6-1-1990

Returns to Women's Education

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CENTER DISCUSSION PAPER NO. 603

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June 1990

Notes: Research for this paper was supported by the Women and Development Division, Population and Human Resources Department, The World Bank.

Center Discussion Papers are preliminary materials circulated to stimulate discussion and critical comments.

This paper was presented at a World Bank conference June 8-9, 1989 in Washington, D.C. and is forthcoming as chapter III in Women's Education in Developing Countries, (eds.) E.M. King and M.A. Hill.

ABSTRACT

Evidence is presented that schooling for women is economically warranted on several grounds: private efficiency or relatively high individual private market rates of return, relatively high social returns augmented by externalities such as decreased child mortality and unwanted fertility, equity in the sense of increased productive capabilities of a group that is relatively poor, and intergenerational redistribution toward the better health and education of children and a slower growth in population. Although investments in the schooling of women have increased with economic development over time within most nations, and with increasing per capita income across nations, there remain major regions of Asia and Africa where the ratio of public investment in the schooling of women relative to that of men is one-half to two-thirds. These large gender differentials in investments in human capital that divide low income countries warrant careful quantitative study to focus informed debate on the economic and demographic costs and benefits of increasing investments in the schooling of women.

CHAPTER III - RETURNS TO WOMEN'S EDUCATION

T. Paul Schultz

Remarkably few detailed studies of returns to schooling for women have sought to clarify social or private investment priorities. As a consequence, no one has looked for an explanation of why the high returns to female education have not attracted more public and private investment in women's schooling, particularly in those countries where women receive much less education than men do. Analysis is needed to understand the origins of the gender differentials in returns to schooling. They may be related partly to the structure of aggregate demand for labor and partly to economic constraints such as per capita income and the costs of delivering school services (Schultz 1987). The gender differences in investment behavior may be perpetuated by the structure of regulations and incentives in public (and private) education systems. They may also reflect family decisionmaking and the preferences of parents who value greater productivity in a daughter less highly than in a son or who are unable to appreciate fully the enhanced nonmarket productivity of better educated women. Understanding why this pattern occurs in some settings and how policy interventions can change family behavior are challenges for researchers and program designers.

RATES OF RETURN TO SCHOOLING

Estimates of the rates of return to education are calculated in two forms. The private return is the internal rate of return that equalizes the present discounted value of the private cost of attending school with the present discounted value of the private after-tax gains the individual recoups in subsequent productive activities. The social return includes, in addition to these private costs and gains, the cost of public and private school subsidies and the gains in increased taxes more educated workers pay, as well as any net positive social externalities that education generates that the individual does not capture.

In practice, relatively few studies of private returns to education even deduct from labor earnings or wage rates what the more educated worker is likely to pay in increased taxes (income and indirect taxes), although doing

so is not conceptually difficult. This deduction would be irrelevant if the number of hours worked were independent of education and taxes were proportionate to wages, assumptions that may be plausible in analyzing the returns to male education. The first assumption conflicts with what is known about the behavior of female labor supply, however.

The distinction between private and social returns to schooling in most empirical studies merely involves including the additional social costs of public expenditures per pupil in the school system in the calculation of the internal social rate of return. Thus, social returns to education are predictably lower than private returns in proportion to the share of the total costs of schooling that the public sector absorbs. This gap between private and social returns to schooling is particularly large for higher education in some relatively poor countries, where attendance at institutions of higher education is rationed and students who gain admission do not necessarily pay tuition and may even receive cost-of-living stipends (Psacharopoulos and Woodhall 1985).

In primary and secondary schools, the opportunity value of the time of those students who are removed from productive work in the family is the primary private cost of schooling, augmented in some cases by private outlays for books, school materials, uniforms, and transportation. On the public cost side, salaries of teachers are the dominant cost in poorer countries; indeed, teachers' salaries in many such countries absorb 80 to 95 percent of public expenditures on education (see UNESCO Yearbooks of Educational Statistics).

The private return to schooling provides the incentive for individuals and families to invest in education, to the extent that they view schooling as an economic investment in the future productivity of the human agent. The consumption value of education provides another motivation for private expenditures on schooling. This motive is not commonly observed, however, and therefore is not analyzed as a differential force affecting the level and mix of a society's educational investments. Families and individuals with equal access to credit and facing the same cost of capital would efficiently invest in education as a form of human capital until the

private return on additional schooling declined to the level of the private cost of capital. Thus, efficiency criteria alone would predispose a family to invest differentially in the human capital of their children, depending on their perception of the ability and opportunities of each child--assuming ability and opportunity enhance the private returns to schooling (see, for example, Becker 1981).

Social returns to education provide one set of guidelines by which a society could efficiently allocate social investments and set priorities among alternative educational programs, producing distinctive types of skills and workers. Individuals capture much of the social return to education, however, so those groups that obtain high private returns for their children will be strong supporters of the status quo. Rent-seeking behavior in the upper and middle classes is commonly a potent political force in low-income countries to raise quality, maintain free access, and if necessary, even ration entry into the better secondary and higher public educational institutions. Though high social returns signal the need to expand a particular segment of the school system, if they are buttressed by high private returns, the public sector should consider using fees (and scholarships) to finance such an expansion or allowing a private educational system to satisfy the excess demand. If social returns are moderate primarily because of social externalities, and consequently private returns are relatively low, the public sector should expect to rely more on its own financing for school expansion.

An alternative criterion for allocating public subsidies to education could emphasize those activities for which the social externalities alone would justify public subsidies for education. Externalities from education are thought to be substantial at the basic primary level and to diminish at the secondary, higher, and more technically specialized levels of university training--levels at which individuals capture more of the social benefits (minus taxes) from their education (Weisbrod 1964). Social externalities are particularly well documented in studies of effects of women's education, but they are rarely cited as a reason for expanding public education for women.

Research that is often produced in combination with university education may itself generate external benefits that are an important source of economic growth. The products of university research are generally freely available to firms and households, but partly because of their accessibility, their productive value is difficult to assess. This potential externality of university training allied to research has not been quantitatively evaluated in many low-income countries, to my knowledge. A possible exception is in the agricultural sciences, in which research and extension are sometimes responsively connected (Evenson 1988).

Patterns in Overall Levels of Social and Private Returns

Psacharopoulos (1973 and 1985) has summarized several estimates of rates of return to education by region and school level. Table 3.1 implies several general patterns in these returns. For example, the more developed the country, the lower the social return to education, both across countries and within countries over time. With notable exceptions, the higher the level of schooling is within countries, the lower the return. The social returns appear to be about twice as large in Africa and Latin America as they are in industrially advanced high-income countries. Social returns in Asia fall between those extremes.

Table 3.1: Average Social and Private Rates of Returns to Education by School Level

Region	Social			Private		
	Primary	Secondary	Higher	Primary	Secondary	Higher
Africa	27	19	14	45	28	33
	(12)	(12)	(12)	(9)	(9)	(9)
Asia	18	14	12	34	15	18
	(9)	(11)	(11)	(5)	(8)	(8)
Latin America	35	19	16	61	28	26
	(8)	(8)	(8)	(5)	(5)	(5)
High-Income Countries[a/]	13[b/]	10	8	19[b/]	12	11
	(6)	(15)	(15)	(7)	(14)	(15)

Note: Numbers of countries reported in parentheses below mean.

a/ Europe, United States, New Zealand, Israel.
b/ Not calculable in the majority of high-income countries, where the comparison group without a primary education is small and highly unrepresentative at younger ages.

Source: Calculated by the author for most recent years when social returns were available at all levels or all but primary level for high-income countries. Original studies summarized by Psacharopoulos (1973) table 14, and (1985) table A-1.

In many low-income countries, the private returns to higher education are twice the social returns, because the public costs of education are a relatively large share of total costs. The exception is Asia, where the social returns to secondary and higher education for the same countries are only moderately lower than the private returns. In this region, the public subsidies are only a moderate share of the total costs. In contrast, Africa and, to a lesser degree, Latin America have provided large public subsidies for secondary and particularly for higher education.

Studies of the rate of return to schooling based on aggregate data are often replicated by estimating earnings functions from individual survey data. In these logarithmic wage or earnings functions, the coefficient on years of schooling approximates the private internal rate of return to schooling (Mincer 1974; Rosen 1977). The appendix to this chapter derives

this relationship under specific assumptions and illustrates why the proportionate logarithmic upward shift in the life-cycle average wage rate associated with each year of schooling approximates the private return to schooling.

The estimated coefficient on years of schooling in a logarithmic wage function tends to be slightly smaller than the estimated private return to schooling derived from tabulated data on earnings and education costs by age groups, as originally performed by Becker (1964). Wage function approximations of the private rate of return to education range from 13-25 percent in Latin America and Africa to 6-9 percent in high-income countries (see, for example, Psacharopoulos 1985, table 3).

Within a country, the pattern of diminishing social marginal efficiency of human capital investments supports the view that public subsidies should focus first on the expansion of primary and then on secondary schooling. These levels not only offer the highest returns, they are also the most widely distributed and hence are more likely to be equitably distributed across economic classes. Private returns tend to be highest in Africa, where large educational investments began only recently. The high private returns in Latin America may reflect the sluggish expansion of public schools at the secondary level in recent decades. Portions of East and Southeast Asia and high-income countries have already achieved substantial levels of human capital investment. In fact, some studies suggest that the social returns to schooling in these countries are roughly on a par with the private returns from physical capital after taxes. Thus, in some regions, public investments in education could be increased efficiently and equitably, whereas in others--more rapidly growing countries--the case for public investment in school expansion depends in part on new evidence of social externalities (see, for example, Lucas 1985; Romer 1983).

This growing body of data and analysis leads to the conclusion that in most developing countries, the demand for more educated labor appears to be increasing at least as rapidly as the supply of more educated labor, although in some cases macroeconomic swings in economic growth cause temporarily high

or low returns to schooling. Relatively little analysis has addressed how structural adjustment has affected private returns to education in the short run and over the longer term.

All the calculations of returns to education neglect the consumption gains associated with schooling and any externalities, or "public good," attributes of education, because consensus is lacking on how to measure and value these benefits.

SCHOOLING RETURNS, FAMILY LABOR SUPPLY, AND SAMPLE SELECTION

Many issues arise in the empirical measurement of returns to schooling. The first class of problems involves the estimation bias introduced by inadequate specification of student ability, parent background, and school quality. Ideally, this bias could be corrected by agreement on specification and by better data (Schultz 1988). Most studies, however, must build on imperfect specifications and data. The direction of the bias these problems may cause in estimating returns to education is unclear, as is their influence on the level of returns for women relative to those for men.

The second class of problems arises because only a portion of the population is asked to report the wage and related productivity information needed to estimate a wage function. A bias is likely if selection into this sample of the population is not independent of the schooling-wage-productivity relationship. The selection problem is likely to be even more serious if the criterion for inclusion in the sample is choice of occupation or migration; plausibly, both are linked to the education of workers. In these cases, the problems of sample selection involve jointly explaining labor market behavior and the determinants of wages. This may be important for comparisons of returns to education of men and women, because men and women work different amounts of time in wage employment and exhibit different labor supply responses.

Labor Supply and Unemployment

Individuals with different levels of education may choose to work different numbers of hours. The rates of return to education will then differ depending on whether they are based on comparisons of hourly wage rates or an annual rate of earnings (Schultz 1968). Adjusting for how people allocate their time to market work in constructing the benefit stream from female education can be important in low-income countries.

According to Mincer's (1974) equilibrium investment framework, the present value of the sum of human and physical capital is not affected by investments in schooling. In this case, the total wealth effect of schooling should be unimportant (see Lindsay 1971).

The voluntary labor supply response to the increased wage rate offered to more educated workers can be decomposed into (1) an income effect and (2) an income-compensated price (wage) effect. Mincer's framework implies that education is associated with a relatively small income effect. Mincer assumes all individuals can borrow at the same interest rate, but this assumption may be less tenable in countries without well-developed loan markets. Where liquidity constraints explain why low-income groups invest less in their children, the more educated should tend to work fewer hours because education will be associated with a wealth advantage and thus be reflected in a demand for more leisure time. This tendency would lead to underestimating the private return to schooling if the comparisons were framed in terms of monthly or annual earnings (see the analysis of Thailand accompanying table 3.7). The more educated would receive part of their return from schooling in the form of increased nonmarket activities, including leisure (see, for example, Mohan 1986, for Colombia). Conversely, the more educated might tend to work longer hours in societies in which family wealth is more equally distributed and student loans and fellowships help the poor invest in human capital. The income-compensated price (wage) effect associated with a worker's education would encourage the more educated to work longer hours. If this were the only effect of education on labor supply,

comparisons of annual earnings would overstate the private returns to schooling.

The partial association of education and hours of market work tends to be positive for youth and married women when other sources of income, such as family's or husband's, are held constant. When returns to schooling are based on variations in annual earnings, the private returns may be overstated because the offsetting loss of nonmarket production and leisure of the more educated is not deducted from the gains in market earnings. The change in wage rates (measured, for example, by annual earnings divided by hours) attributable to education is thus a better approximation of the private welfare benefits from schooling than are changes in weekly, monthly, or annual earnings, particularly for women. The preferred dependent variable in the earnings function used to estimate private returns to schooling is the logarithm of the hourly wage rate, deflated by local prices.[27/]

Unemployment may be a productive period during which workers search for job opportunities that match their skills. If unemployment is greater among more educated youth during a relatively short period after they complete their schooling, the opportunity cost of their job search should be included along with the other costs of schooling that eventually will be recouped by enhanced earnings in employment (Blaug 1973; Turnham 1971; Berry 1975; Gregory 1980; Berry and Sabot, 1984). Unemployment is generally lower among the more educated than among the less educated a decade after they enter the labor market. If this pattern does not reflect a current choice of the worker between nonmarket activities and market work, then unemployment may be called involuntary. Thus, one of the private gains from increased schooling is enhanced access to regular work opportunities in the market labor force and hence a lower incidence of involuntary unemployment.

27/ To introduce measures of labor supply among the explanatory variables in the wage function is clearly inappropriate unless they are treated as endogenous variables that could also respond to education. Another serious problem in estimating schooling returns is to explain the variation in annual or monthly earnings by the variation in the number of hours or weeks individuals work.

Typically, analysts only address patterns of unemployment by level of education among men; no studies were found on the differential effects of unemployment on returns to schooling for women (see Tilak 1987, for some evidence). Unemployment rates are frequently higher for women than for men, as shown in table 3.2, although the reverse is true for a few countries such as Algeria, Syria, Iran, India, and South Korea. In other countries, such as the United States and Puerto Rico, the difference by sex in unemployment rates has reversed over time. The issue here is how to incorporate differences in unemployment among men and women in the labor force into the calculation of the expected sex-specific returns to schooling.

Table 3.2: Unemployment Rates in Selected Countries by Gender (percent of labor force over 15)

Site (Year)	Men	Women
Algeria, Alger (1966)	25.9	6.6
Ghana, Large Towns (1960)	11.5	11.8
Colombia, Bogota (1968)	10.3	18.5
Argentina, Buenos Aires (1965)	2.9	7.0
Guyana, Urban Areas (1965)	18.4	27.7
Panama, Urban Areas (1963/64)	8.9	13.3
Puerto Rico (1969)	11.2	7.8
Trinidad, Tobago (1968)	14.0	16.0
Thailand, Bangkok (1966)	3.2	3.4
Sri Lanka, Urban (1966)	12.9	25.9
Taiwan (1966)	2.1	6.8
India (1961/62)	3.4	3.2
S. Korea, Non-farm (1966)	9.3	7.9
Malaya, Urban (1965)	7.4	16.7
Philippines, Urban (1965)	10.8	12.9
Syria (1967)	6.2	5.1
Iran, Tehran (1966)	4.6	4.0

Source: Turnham (1971) table III.2, pp. 48-50

Because labor force participation and hours worked in the market labor force are more responsive to market wage opportunities for some members of the population than for others, differences in unemployment rates may parallel differences in the labor supply elasticity of demographic groups and

reflect their range of employment opportunities and different job search behavior. The elasticity of labor supply with respect to own market wage rates tends to be greater for married women than for married men or for single women, and greater for single men than for married men (Schultz 1981).

Table 3.3 shows unemployment for adult males and females by marital status. Unemployment rates tend to be greater for married women than married men, while unemployment is greater among single men than married men. The unemployment rates are similar in magnitude for single men and women, except in Malaysia and Philippines, where the tabulations reported by Turnham (1971) have other special features. These patterns suggest that differences in unemployment for men and women may be related to their labor market behavior. Even if unemployment is viewed as purposeful job-search activity, standard estimates of labor earnings by schooling of men and women should in the future be adjusted (downward) to compensate for the incidence of unemployment, or time that is not reimbursed and also is not used in home production. If this form of unemployment decreases with education, as Turnham (1971) and others find, the private rate of return to schooling should increase when adjusted for unemployment. Research has not confirmed how this adjustment will affect the comparison of private returns to the schooling of women and men.

Table 3.3: Unemployment Rates in Urban Areas of Selected Countries by Gender and Marital Status (percent of labor force)

Site, Population (year)	Married		Unmarried	
	Men	Women	Men	Women
Argentina, Buenos Aires, ages 25-44 (1976)	1	6	na	na
Brazil, Sao Paulo, ages 25-44 (1980)	1	7	na	na
Bolivia, La Paz, ages 25-44 (1980)	3	14	8	9
Colombia, Urban Areas, ages 25-44 (1973)	5	8	12	10
Paraguay, Asuncion, age 25-44 (1979)	1	5	6	6
Peru, Urban Areas, ages 25-44 (1974)	2	3	8	6
Uruguay, Montevideo, ages 25-44 (1978)	3	13	5	9
Malaya, urban areas, experienced labor force (1965)	22.0	10.0	24.0	15.0
Philippines, urban areas, head of households (1965)	3.7	11.7	7.4	2.9

na = Not available from underlying study.

Source: Reyes (1982) table 5-11, p. 147; Turnham (1971) table III.5, p. 53.

Many studies that estimate the returns to education appear to exclude the unemployed and to neglect the variation in labor supply. One reason for omitting the unemployed is the lack of an appropriate wage. This omission is another form of sample-selection bias that arises in most studies that are restricted to people reporting wages or labor earnings. In addition, unemployment is probably more difficult to measure reliably in low-income countries than in high-income countries because of the greater ambiguity in classifying activities as nonmarket or market. Nonetheless, returns to schooling should be estimated for everyone to avoid potential sources of bias in sample selection. Simultaneous analysis should therefore evaluate how education affects market labor supply behavior, unemployment, and the wage rate of those employed.

Occupational Choice

Returns to education are often calculated for subpopulations. If these subpopulations are defined by characteristics over which the individual has no control, such as race, caste, or gender, the interpretation is straightforward, though differential participation in the wage labor force remains a potential source of bias in intergroup comparisons. When the subpopulations are not closed, however, as in the case of regions because of interregional migration, or in the case of occupations because education may qualify some for entry into an occupation, a complex problem of selection bias may be present.[28/]

Possibly the most important occupational distinction is between wage and salary earners and self-employed workers. Most research on returns to schooling focuses on employees because their labor earnings can be observed more directly; self-employed respondents must be asked to deduct purchased and imputed values of inputs from gross income. When employees are a large fraction of the labor force, as in high-income countries, omitting the self-employed has become a standard, if indefensible, practice in empirical studies of educational returns. When wage earners are a small fraction of the labor force, however, the synthetic age-wage profile across education groups of employees may be a misleading basis for estimating the lifetime returns to schooling in the overall economy. Yet, relatively few studies analyze how selection into the employee sample could bias the estimated returns to education (see, for example, Anderson 1982, Griffin 1987).

28/ It is still tempting to decompose the effects of such exogenous traits as education, race, or gender on earnings and to appraise what portion of the effect occurs because of occupational sorting and what portion occurs within occupations (Polachek 1979). Because the stochastic processes determining occupation and earnings are undoubtedly affected jointly by unobserved factors, this form of decomposition of a simultaneous equation system is feasible only when identifying restrictions are known a priori; that is, a factor known to influence occupational choice or placement, but not earnings, can be used to explain occupational sorting but justifiably can be omitted from the structural wage equation. Studies nonetheless assume, without justification, that occupational choice and earnings are stochastically independent and can therefore be modeled as block-recursive.

The probable covariance between an individual's choice of whether to be a wage earner or a self-employed worker and that person's potential productivity can be ignored to simplify the problem. Separate estimations are then reported without correcting for sample selection in each wage function for the self-employed and the wage earners. The coefficients on a worker's years of schooling are then compared within the two strata. The proportionate upward shifts in wage rates or earnings associated with schooling tend to be of a similar magnitude in Thailand (Chiswick 1979), Colombia (Fields and Schultz 1982), and Israel (Ben-Porath 1986). The increase in transitory income variations in the earnings of the self-employed is often emphasized in the economics literature, but its relevance to the returns realized from education has not been explored.

These comparisons of self-employed and wage earners have two weaknesses. First, they assume that the self-employed are willing and able to report their labor earnings net of the value of purchased and owned inputs such as rental value of owned land and business capital. In fact, in developed countries, such as the United States, farmers and unincorporated entrepreneurs report incomes to surveys and tax authorities that are much lower than the income the national accounts impute to them. How this understatement of self-employed income would bias comparisons among education groups is unclear. To reduce this potential source of reporting bias, Teilhet and Waldorf (1983) followed a small sample of self-employed in the informal sector of Bangkok to derive their own estimates of the net hourly return to the labor of the self-employed. The returns to schooling appeared to be no less for them than for wage earners, although obtaining more education predisposed men in the Bangkok sample to obtain a job for wage employment.

The second weakness is that the fraction of the labor force that is self-employed often increases with age groups in a cross-section. The life-cycle process of accumulating skills, experience, contacts, and physical capital appears to increase the likelihood that an individual will become self-employed (Fields and Schultz 1982, Ben-Porath 1986). In approaching retirement, self-employment may also afford a worker more flexible work

opportunities than does wage employment (Fuchs 1980). A secular tendency exists, however, for the share of self-employed workers in the labor force to decline with economic development (Kuznets 1966). Little empirical evidence is available to help disentangle the effects of life-cycle changes from those attributable to secular changes during development.

Nonmarket Returns to Schooling and Sample-Selection Bias

Nonmarket returns to education cannot be valued in comparable monetary terms and readily aggregated. Therefore, evidence of the returns to women's schooling tends to rely on analyses of differences in productivity among wage earners who have different amounts of education. The central problem in constructing the statistical comparisons from which to estimate the returns to schooling of women is to correct for any potential bias that might be introduced into the analysis because the women who work for wages may be more (or less) productive than the average person.

Statistical procedures designed for dealing with such a problem of sample-selection bias have been developed in economics in the last decade (Heckman 1979 and 1987). They require information on a variable for the entire population that is statistically correlated with the probability of being in the wage earner sample, but the variable must not be related to variation in market productivity (wages) that is left unexplained after controlling for education, post-schooling experience, and so on.

This sample-selection methodology permits estimation of the effect of education on market productivity for the average person so that an unbiased estimate can be obtained of the private and social returns to schooling. If a particular person does not work in a wage job, it is because that individual can work in a more productive job at home or as a self-employed worker, or because the extra costs of finding and holding a wage job exceed the financial gain. To correct an analysis of wage functions for this potential sample-selection bias requires a variable that influences only a person's net nonmarket reservation wage but not her or his market wage offer. Such a variable could be the family's nonearned income, land, or other assets that

raise the persons's productivity in self-employment and also increase the individual's demand for leisure, assuming leisure is a "normal" economic good.

Sample-selection corrections should be performed routinely in the estimation of wage functions that are designed to estimate the average private returns to schooling for women and for men. Although this practice is spreading, the methodology generally has not been identified by a common set of economically justified variables. The correction procedure may be particularly important in low-income countries, which tend to have a higher proportion of family workers and self-employed workers, and for women, because the proportion who earn wages can be relatively small.

Correcting for this sample-selection bias by satisfactory identification restrictions sometimes substantially change the estimated private rates of returns to schooling. At this time, however, we do not know why these differences occur in certain countries and not others, or why they vary by level of schooling. If these studies are indicative of what future research will find, the proper statistical adjustment of wage functions for sample-selection bias may not uniformly change the relative ranking of educational returns to women and men. Improving the empirical research methods, however, should raise our confidence in the basic facts and improve our forecasts of educational investment priorities, by level and gender, over the course of economic development in a particular country. These improved empirical estimates of the returns to schooling should also help explain long-run, simultaneous shifts in the aggregate supply of and demand for educated labor that occur during the process of modern economic growth.

EMPIRICAL EVIDENCE OF MARKET RETURNS TO EDUCATION

Many limitations to the use of intergroup comparisons for estimating returns to schooling are beyond the scope of this paper; they are discussed elsewhere (see, for example, Griliches 1977, Schultz 1988). One such limitation is the inadequacy of the statistical controls to account for individual ability (that is, the bias of omitted inputs or selection by comparative advantage) (Willis and Rosen 1979; Heckman and Sedlacheck 1985).

Another is the neglect of quality of education in the wage function; because quality tends to be directly related to the quantity of schooling individuals receive, the returns to additional years of constant-quality schooling may be overestimated (Welch 1966; Behrman and Birdsall 1983).

No consensus exists on precisely which variables should enter the wage function or how to identify statistically those individuals who invest in schooling or work for wages in the labor force. Different strategies for constructing the comparison groups may yield private rates of return to schooling that are substantially lower, or sometimes higher, than the simplest logarithmic wage function that includes (1) years of schooling in linear or spline form and (2) a quadratic in years of post-schooling experience (Mincer 1974). The controversies over the methods of estimating returns to schooling do not appear to be germane to the purpose of comparing the rates of return and determining investment priorities between male and female education, because most of these problems that might bias estimates of returns to education operate similarly for women and men, with the possible exception of labor supply. Nevertheless, assessing precisely the absolute level of such returns to private and public resources invested in the education of women remains an important, if subsidiary, objective.[29/]

Labor Supply and Rates of Return to Schooling: Estimation Methodology

Many studies have reported private rates of return to schooling of men and women (summarized in table 3.4). The studies are not comparable, however, because they use different conceptual and empirical methods. Several related aspects of the estimation methodology need to be revised and standardized to improve our confidence in the comparability and accuracy of such estimates for determining investment priorities.

29/ For example, if more able students self-select themselves into the more educated comparison group, the returns to education could be overstated unless a selection-corrected measure of the private returns to schooling is computed (Willis and Rosen 1979). But this form of selection might not necessarily bias the comparison of the directly measured returns of men relative to women, if ability operates in an analogous way to influence who goes to school among both boys and girls.

Table 3.4: Returns to Education by School Level and Gender

Country (Year)	Estimation Method	Primary		Secondary		Higher	
		Male	Female	Male	Female	Male	Female
Colombia, Bogota (1965)	II	18.2	nil	34.4	18.9	4.5	5.3
Kenya (ca 1960)	I	21.7	7.1	23.6	19.5	nr	nr
Malaysia (ca 1960)	a/	9.4	9.3	12.3	11.4	10.7	9.8
Brazil (1960)	a/	17.9	38.6	nr	nr	nr	nr
South Korea (1971)	a/	nr	nr	13.7	16.9	15.7	22.9
Taiwan (1982)	a/	8.4	16.0	nr	nr	nr	nr
Puerto Rico (1959)	a/	29.5	18.4	27.3	40.8	21.9	9.0
Andra Pradesh, India (1977)	II	8.9	11.8	8.7	11.9	6.2	8.9
	I	7.2	0.3	6.8	2.41	5.5	5.5
Ivory Coast (1985)	II	18.3	5.5	17.0	28.7	21.1	13.6

nr = Not reported.

Note: I - includes participation rate in labor force to deflate returns, depressing female returns disproportionately.
II - estimates wage rate relationship without labor force adjustment.

a/ Estimation method not known.

Source: Colombia, Bogota--Schultz 1968, table 7, hourly wage; Andra Pradesh, India--Tilak 1987, table 6.8), average return for school level; Ivory Coast--van der Gaag and Vijverberg 1987, appendix 2; other countries--Psacharopoulos 1973, table 4.5, and 1985.

First, how should the potential productivity gains attributable to schooling be adjusted when people work different amounts of time in the labor force? Second, how should the effect of education on nonmarket productivity be estimated and combined with market productivity effects to yield average returns to schooling for the entire population? Third, what techniques can correct for the potential bias that enters these studies when direct observations on productivity are inevitably limited to only a portion of the population--say, to those who report labor income and hours worked?

In the first studies of the association between education and labor earnings, private rates of return were calculated under the assumption that better educated people benefit from schooling only to the extent that they

hold a job in the labor force (and report earnings).[30/] Thus, if a year of additional schooling raised the wage rates of men and women by x percent per year and they both worked full-time in the labor force, the life-cycle internal rate of return to the opportunity cost of attending school for that year was x percent for men and women. If, however, women worked only half-time in the labor force after completing their schooling, while men worked full time, the conclusion was that women earned only half the rate of return of men on their year of schooling.

Becker (1964), in his seminal contribution on this subject, observed that the lower return to women's education attributable to their lower participation in the labor force was consistent with the smaller proportion of women than men attending college in the United States in the 1950s (p. 178). Later empirical studies and surveys that specifically addressed gender differences in rates of return to education used Becker's methodology (Hines, Tweeten, and Redfern 1970; Thais and Carnoy 1969; Psacharopoulos 1973; Woodhall 1973). The implicit assumption underlying this research was that

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30/ From the perspective of the early 1960s, this empirical strategy may have reflected a desire to avoid overstating the returns to schooling, because the concept was novel and controversial. The resulting differences in empirical methods has led to reports of women's school returns being deflated for nonparticipation, in some cases by half or more. In other reports, the estimates are drawn directly from wage functions without deflation or sample-selection correction.

schooling had no effect on the productivity of people working outside of the market labor force.[31/]

A large number of subsequent empirical studies have challenged this assumption. They indicated that education increases the productivity of time in nonmarket production, particularly in the case of women (Michael 1982; Haveman and Wolfe 1984). Moreover, the opportunity cost of the time of females in school was not symmetrically discounted; girls were implicitly assumed to be giving up a full-time job in the labor force to attend school, a pattern that might not have been true. These working assumptions for estimating the rates of return exert a downward bias on the rates of return to

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31/ The analysis of educational returns is complicated if education influences the supply of labor (Schultz 1968). An increase in a worker's human capital is expected to exert an income effect reducing market labor supply and a substitution effect increasing market labor supply. If individual or the family bears all the costs of acquiring the human capital and those costs exactly offset the market discounted gain in earnings, then the income effect of the increase in human capital is zero. This is the implicit assumption in the equilibrium investment model developed by Becker (1964) and Mincer (1974) and elaborated by Lindsay (1971).

If no income effect is associated with education, the more educated should work more hours, because the remaining substitution effect on labor supply must be positive. But empirical exceptions can be readily found, such as in Bogota, Colombia, where the university educated worked less than those with only secondary schooling (Schultz 1968) and Thailand, where in 1981 men with more university training worked fewer hours (Schultz 1989). Thus, in reality, both income and substitution effects may be associated with the acquisition of schooling, and the return to schooling should include the income effect but exclude the labor supply effect induced by the substitution effect. In practice, if the dependent variable of the earnings function is the logarithm of the hourly wage rate, the coefficient on years of schooling approximates the private rate of return, holding labor supply constant. This procedure is correct if the income effect is negligible, as assumed in the equilibrium investment model, and the substitution effect on labor supply should be disregarded as a compensating loss in leisure. If the more educated work fewer hours, which implies educational attainment is associated with a gain in wealth, then this procedure will underestimate the private rate of return to schooling.

groups, such as women, that participate in the labor force less than the average person does or that work more often as an unpaid family worker.[32/]

Becker (1964) and Mincer (1974) also analyzed the differences across individuals in annual earnings, combining the effect of schooling on the worker's potential productivity per hour with its potential effect on market labor supply and unemployment. The empirical consequence of this decision is not theoretically obvious, but any empirical tendency for unemployment rates to be lower and labor supply to be larger among the better educated would bias estimates of the rate of return to schooling upward, when the logarithm of annual or monthly earnings is used as the dependent variable rather than the (preferable) logarithm of the hourly wage rate.

The usual assumption in labor economics is that people enter the market labor force when the market wage they are offered (after taxes and fixed costs of entering the labor force) exceeds the reservation wage that is determined by their marginal productivity in nonmarket or home activities. When an individual shifts time from nonmarket to market work, the national income may increase, but the broader welfare indicator of "full income" (Becker 1965), or the potential productivity of the human agent, remains unchanged. As people vary the hours they work in the market labor force, the observable market wage rate continues to approximate their nonmarket productivity. Only when they leave the labor force entirely can we infer their nonmarket productivity exceeds their market wage offer. The problem is how to estimate the productivity of nonmarket time for nonparticipants in the labor force, by education, so as to incorporate this information into the

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32/ Becker (1964) used the average earnings (of those with earnings) from tabulations of the 1950 Census and apparently then deflated these benefit streams by participation rates. This approach ignored the sample selection of those who had positive earnings, as well as the problem of mixing productivity per hour and labor supply responses associated with education. Mincer (1974) examined the 1960 Census public-use sample and fit the individual's logarithm of annual earnings to education and other variables. His analysis included only individuals with positive earnings, but no correction for the potential bias due to this sample-selection was made. Mincer's and Becker's analyses focus primarily on males and not females, and some of these issues are less serious for the analysis of males.

calculation of the returns to education. Estimating the nonmarket productivity of nonparticipants requires that we specify the mathematical function for nonmarket productivity function (for example, linear or nonlinear) and show how its parameters are identified. There is no consensus on how this should be done, and it is not attempted here.

The original methodology of Becker and Mincer for estimating the returns to schooling can be improved, for example, by assuming that education affects hourly labor productivity in market and nonmarket work by the same amount, or that it is neutral between these sectors. The coefficient on years of schooling in a logarithmic hourly wage function is then an estimate of the private of rate of return to schooling. Research must now appraise the severity of the bias remaining in this revised simple estimation methodology because of the underestimation of the nonmarket productivity of those not participating in the labor force.

Fixing the effect of schooling on nonmarket productivity to zero appears, with hindsight, to have been unjustified and to have led to a large downward bias in the estimated rates of return to education for women. The bias in the estimated rates of return attributable to analyzing annual earnings, rather than the hourly wage rate, cannot be generally prescribed, for it depends on the joint determination of labor supply behavior and wage functions in a specific society. Similarly, research is only beginning to evaluate the bias on estimates of the return to schooling of women attributable to the selected sample of wage earners. This bias could overstate or understate the true rate of return to education for the entire population (Heckman 1979 and 1987).

Theoretically, the variable needed to identify the nonmarket productivity (or reservation wage) function is a household fixed productive factor that affects the individual's nonmarket productivity but that does not alter his or her labor productivity to a firm in the market. In the short run, children have been viewed as such a variable in that they raise a woman's productivity only in the home (Gronau 1974). Over the life cycle, however, this variable is also jointly determined and responsive to labor market wage

rates. Thus, it should be viewed as endogenous or as determined within the same framework (Schultz 1981). Land ownership and family business assets, and the market productivity of a person's spouse may be more satisfactory measures of fixed household endowments that enhance the value of an individual's time in nonmarket activities. The choice of this identifying restriction determines how the estimates of the market wage function are interpreted and hence whether the implied rate of return to schooling is a satisfactory estimate for the entire population or only for the nonrandom sample of wage earners.

If more than one selection process is used to define the sample for estimation, and the selection processes have different determinants, multiple sample-selection equations and corrections are used (see for example, Catsiapis and Robinson 1982). For example, participation in the market labor force and acceptance of wage employment may be responses to different home and market constraints. If the marginal product of labor is measured with less error for wage and salary workers than for self-employed workers, this scheme of double sample selection may be appropriate, to reduce measurement error, despite the loss in the final sample size.

Many studies of the returns to education tend to include only wage earners and thus exclude the self-employed and unpaid family workers for whom a wage is difficult to infer or measure precisely. This group is a relatively small segment of the labor force in high-income countries, but it is a major part in low-income countries; for example, nonmarket workers, the self-employed and family unpaid workers together represent about half of the adult male population and two-thirds of the adult female population (Schultz 1989). Thus, any bias from sample selection could be important in analyzing the educational returns for men, as well as for women, in low-income countries (Nakamura and Nakamura 1988).

Empirical Studies: Selective Review of Evidence

Table 3.5 summarizes the private rates of return to years of schooling for men and women in several Latin American countries. All of the related studies used a common conceptual and statistical methodology (Schultz 1980a). Although these estimates deal plausibly with the labor supply issue by analyzing the hourly wage which does not erroneously deflate female returns by labor force participation. They do not, however, correct for wage sample-selection bias. Because the samples are small, some of the estimates are imprecise. Overall, however, these studies provide no clear evidence that returns to schooling differ systematically by gender. Returns do differ considerably across countries, however, presumably because of differences in macroeconomic conditions and the level of past investments in schooling (Schultz 1988).

Table 3.5: Estimates of Private Returns, to Education, in Selected Labor Markets and Years (percent per annum)

Site	Year of Survey	Internal Rate of Return: Ages 25-44 Men	Ages 25-44 Women	Ages 45-65 Men	Ages 45-65 Women
Argentine, Buenos Aires (estimates similar in 1976)	1980[a/]	9.3	6.6	10.0	11.0
Bolivia, La Paz (estimates similar in 1976)	1980	9.8	11.0	9.6	6.7
Brazil, Sao Paulo (estimates higher in 1980)	1971	5.4	6.3	6.0	6.1
Colombia (estimates lower in 1980)	1973	18.0	18.0	16.0	14.0
Paraguay, Asuncion (estimates similar in 1977)	1979	11.0	8.0	10.0	11.0
Peru	1974	14.0	14.0	11.0	19.0

Note: Private returns refer to the estimated coefficient (times 100) on the variable years of completed education in a logarithmic hourly wage rate regression which also includes post-schooling experience, experience squared, and some regional or migration origin variables. Samples vary in size from 21 to 3,478, but all estimates are statistically significantly different from zero at the .001 confidence level ($t > 2.83$). The selection only of workers in the labor force for whom wage rate could be calculated is not treated as a specific source of bias in these estimates.

[a/] The available age groups in Argentina are 25-49 and over 49.

Source: Schultz (1988).

An analysis of the returns to education in Andra Pradesh, India illustrates how sensitive the calculations of returns are to the treatment of the rate of labor force participation by women (Tilak 1989). Both the private and the social returns to schooling at virtually every level are greater for women than for men when the returns are adjusted only for unemployment. When nonparticipation in the labor force is also factored into the calculation, as Becker proposed, the private rate of return for women is less than it is for men (see results for Andra Pradesh in table 3.4). This study also documents the lower public cost of female versus male education and the lower opportunity cost of time for female than for male students. The adjustment for nonparticipation of women apparently is not introduced to deflate the

opportunity cost of female student time but only to deflate the stream of benefits from work in the labor force.

A study of Sri Lanka also confirmed that women's return to schooling, when not deflated by labor force participation rates, exceeds that of men. The private rate of return to completing the general certificate of exams at the end of secondary school is three times higher for women than for men in urban areas (36 versus 13 percent) and twice as high in rural areas (14 versus 7 percent). At the university level, however, the rates of return for men and women in Sri Lanka appear to converge (Sahn and Alderman 1988, table 17).

Fixed-effect estimation procedures provide another approach to eliminating the bias that may arise from certain types of unobserved or omitted variables in a relationship. A cross-section is drawn from a number of distinct localities in which the price and quality of market goods and public services may differ. If these local market variables influence the productivity of schooling or its quality, then they should be controlled for in estimating the returns by varying only the years of schooling. In this case, introducing a fixed effect for every school district into the wage function removes any bias attributable to the omission of school quality, which might be correlated with the quantity of schooling received. The effect of other local market variables, such as size of schools, cannot then be estimated, because they do not vary within the community. To the extent that the quality of local schools changes at different rates over time across regions and that individuals in a school district move across regions or attend more than one school and work in regions different from those in which they attended school, the community fixed effect becomes a less adequate control for school quality.

Family background probably has its own impact on average ability, through genetic and environmental mechanisms that instill motivations and habits and also influence the quality of schooling that siblings receive. If these family background characteristics affect productivity and are correlated with years of schooling, their omission from the wage function would in all

likelihood also bias upward the estimated rate of return to schooling. One strategy for dealing with these unobserved characteristics is to introduce fixed effects for each family. The estimates of schooling returns are then based only on within-family variations in worker productivity. This procedure, however, may increase the relative importance of measurement error by eliminating all between-family variation. Exaggerated measurement errors would bias to zero the within household fixed-effect estimates of schooling returns (Griliches 1977 and 1979). Household fixed effects are, therefore, likely to represent a lower bound on the estimates of the effects of schooling on market productivity. Moreover, the restriction of the estimation sample to those residing in a family that has another wage earner may itself seriously distort the comparison group and thus bias the return estimates in other directions.

Private rates of return to schooling have been estimated for men and women from a 1986 survey of Indonesia. This study compares standard estimates of the wage function to those that include both community fixed-effects (proxy for school quality and the like) and household fixed-effects (proxy for family background correlates) (Behrman and Deolalikar 1988). Table 3.6 shows returns for three increments of schooling--primary, general senior high school, and university.[33/] Private rates of returns to schooling for women in all comparisons exceed those for men, and (as expected) the estimates that include community and household fixed-effects are between 9 and 24 percent smaller than those obtained from the standard regressions that include interfamily and intercommunity variation. These estimates do not attempt to control for the potentially unrepresentative character of the sample of wage earners, nor are the two sets of estimates based on the same sample, because 16 percent of the

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33/ A logarithmic monthly earnings function is estimated pooling men and women; this function includes dummy variables for nine levels of schooling and a quadratic in age. Parameters are estimated for the difference between male and female coefficients for all variables, including the intercept. The community and household fixed effects are believed to control for possible school quality variation and the effect of family background on earnings. Unfortunately, the ordinary regression estimates and those including the fixed effects are for different samples, raising the possibility that the differences reported may be due to the different samples and not due to the introduction of the fixed-effect controls.

wage earners included in the first set of estimates apparently did not reside in a household with another wage earner and are therefore excluded from the fixed-effect estimates (Behrman and Deolalikar 1988, table 3). Differences in the private rates of return estimated for women and men in Indonesia change moderately as fixed effects are added for the community and household, with the difference decreasing returns at the primary school level and increasing returns at the university level.

Table 3.6: Implied Private Return to an Additional Year of Schooling in Indonesia by Gender (percent per annum)

Sex, Controls	Primary	General Senior High	University
Females:			
Without fixed-effect controls	9.1 (21.1)	11.8 (43.4)	12.4 (27.8)
With community and family fixed-effects controls	6.9 (17.3)	9.6 (35.3)	10.9 (24.7)
Males:			
Without fixed-effect controls	7.6 (2.64)	8.2 (10.9)	9.2 (6.41)
With community and family fixed-effects controls	6.1 (1.43)	6.2 (10.8)	8.4 (5.23)

Note: The absolute value of t ratios are reported in parentheses beneath the coefficients in the case of female returns, and for the difference between the male and female regression coefficients beneath the male returns. Thus, a significant t ratio under a male return suggests that the rate of return on schooling for men and women differ by a statistically significant amount in this pooled earnings regression.

Source: Behrman and Deolalikar (1988), table 2.

Chiswick (1976) developed a technique for including self-employed workers in the estimation of an annual earnings function along with wage earners, thereby avoiding sample-selection bias due to analyzing only wage earners. Her approach attributed a share of self-employed earnings to entrepreneurial capital or risk-taking. Based on an analysis of Bangkok from

the 1971 Socioeconomic Survey of Thailand, male wage earners (not self-employed at all) received a 10.4 percent return on their years of schooling, whereas females received a 14.5 percent return. Including part- and full-time self-employed in the sample reduced the returns to schooling only slightly, to 9.1 percent for men and 13.0 percent for women. The inclusion of the self-employed increased the urban estimation sample by 39 percent for males and by 53 percent for females. In both cases, women's returns exceeded those for men, but those who are self-employed reported slightly lower returns on their schooling than did wage earners. This is broadly consistent with the pattern of more women with education beyond primary school working in wage jobs than the less educated. Whether underreporting of incomes by self-employed biases such estimated returns to schooling--and if so, by how much--is uncertain.

Few studies of the relationships between wage rates and schooling have assessed how taking the selective sample of wage earners biases findings (see, for example, Anderson 1982; Mohan 1986; Griffin 1987; King and others 1986; Schultz 1988). Moreover, these studies often deal with men alone or women alone and thus do not help assess whether the bias due to sample selection modifies systematically comparisons of male-female estimated returns to education, as reported in tables 3.4 and 3.5. This is an important issue for public policy but one that has received surprisingly little empirical study.

Griffin (1987) analyzes the earnings of married women in the Philippines in 1980 to appraise estimates of schooling returns subject to alternative methods for dealing with sample-selection bias. He estimates a nonmarket (reservation) wage function and a function for market wage offers. The reservation wage function determines the shadow value of nonmarket time of the individual, and hence what the individual requires to induce him or her to enter the market labor force. Heckman's selection-corrected model is identified within the context of the family or bargaining labor supply model. A standard log-linear specification of the earnings function is estimated in

which returns to schooling are constant across schooling levels.[34/] The selection-corrected maximum likelihood estimate of schooling returns is 18 percent, compared with the conventional estimate of 14 percent (based on only the one-third of the sample who earn wages). In this case, adopting a sample-selection correction procedure increases, the estimated returns to schooling for women and the selectivity term is statistically significantly different from zero, showing that the sample of wage-earning women is not a random sample of the population with regard to their wage rates.

King (1989) analyzed the earnings of women in the 1985-86 Peruvian Living Standard Survey. A probit equation for women participating in paid employment (that is, both wage earners and self-employed) is used to estimate an hourly earnings function with Heckman's (1979) two-stage procedure. The sample-selection correction decreased the rate of return for women from 12.2 to 12.0 percent for primary school, from 8.0 to 7.8 percent for secondary school, and from 6.8 to a -1.7 percent at the university level (if a diploma is received after four years of study) (King and others 1986; tables 10, 11, and 12). As in Griffin's study, the family's nonearned income and husband's characteristics are included only in the paid-participation equation (along with the woman's marital status and a variety of more controversial identifying variables).

Khandker (1989) subsequently used the same Peruvian Living Standard Survey data to examine the returns to schooling for both men and women. He restricts his analysis to wage earners and identifies the sample-selection probit equation by the family's land holdings and unearned income, as well as the individual's marital status. The return estimates appear to be relatively robust to variations in this list of identifying variables included only in the sample-selection equation. For the country as a whole, women's returns

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34/ The nonmarket (reservation) wage of the wife is affected by the family's land, ownership of a business, assets, nonearned income, and her husband's education and experience. These variables are added to the wage-status probit equation. The Heckman (1979) two-stage estimate, which is less efficient, yields an estimate of private returns to schooling of .16 (Griffin 1987, table 3).

increase when controls are introduced for sample selection, and returns are then marginally higher for women than for men at the secondary and higher schooling levels. At the primary school level in the metropolitan area of Lima, however, the returns are low for both sexes, but they are, lower for women than for men (2 percent compared to 2.5 percent). The same pattern of low returns to primary schooling for women has been noted elsewhere in metropolitan Latin America (see Schultz 1968) and has led some researchers to attribute this pattern to domestic servants which they then exclude from samples in estimating wage functions (Mohan 1986).

The 1976, 1981, and 1986 Socioeconomic Surveys of Thailand permit further evaluation of the effect of sample-selection bias on estimates of the private rates of return to schooling for both women and men. In this case, the analysis incorporates two selection correction terms representing the probability of being in the labor force and being a wage earner. These selection equations include family nonearned income, hectares of family land that are irrigated or unirrigated, and the standard market wage rate determinants, including years of schooling completed at the primary, secondary, and higher education levels. Land ownership and nonearned income raise the nonmarket reservation wage and thereby reduce the likelihood that a person will take a wage job or work at all in the market labor force.

Education does not exert a monotonic effect on the labor force and wage earner status of Thai men or women (Schultz 1989). An individual with primary schooling is less likely to be a landless wage laborer in this primarily agricultural country. The more years of secondary schooling an individual has, the higher are the chances that she or he is working for a wage. Each year of university education strongly increases the likelihood of working in a wage or salary job. Herein is a clue why the sample-selection bias can operate in different directions at different levels of schooling. Many landowners are also wage earners. If they have enough land, however, they presumably withdraw from the wage market to cultivate their own land full time. The critical question is whether land is exogenous or merely a proxy for self-employment; in other words, is land a legitimate variable to use to identify the selection model?

An additional problem in specifying a wage function to estimate returns to education in low-income countries is how to model the regional segmentation of labor markets. Without interregional migration, wage functions should be estimated separately for each region. The wage differences related to education within a region would then be the appropriate parameter determining priorities for private investment in schooling in that closed region. Interregional migration does occur, however, and more educated persons tend to migrate more frequently than others. Generally, they move from lower to higher wage markets and from rural to urban areas. In Colombia, for example, as much as half of the lifetime returns to schooling for the children of rural residents is realized by the increased likelihood that the children will migrate from the rural to the urban labor market (Schultz 1988). Analysis of this would require knowing where people migrated from, the costs they incurred in moving, and where they received their schooling. Alternatively, holding an individual's current residential regional labor market statistically constant purges from the wage function an estimate of the return to schooling that arises from higher wage regions which is more frequent among the better educated (as it clearly is in Latin America and the United States) (Schwartz 1976). Models with and without regional shifters provide a useful range of estimated returns to schooling. The greater the interregional mobility (as, for example, in Taiwan compared to China), the stronger the case for treating the entire country as a single labor market when estimating school returns.

Regional labor market nominal wage differences also may reflect compensating variation for price levels and reinforcing variation in the quality of subsidized public services. Nominal wage differences may not, therefore, measure accurately real wage differences. Urban high-wage regions have more and better schooling, and regional shift variables in a wage function may also reflect this difference in the quality of schooling embodied in workers across regions (Behrman and Birdsall 1983). Other than school and health services, other prices particularly for housing, are generally higher in urban high-wage regions. On balance, regional nominal-wage differences probably exceed real-wage differences, if public services are a relatively

small part of family consumption. Estimating the participation and wage functions with and without regions as explanatory variables should at least help to assess the importance of migration in the estimation of school returns. The lack of information on migration in the Thailand survey data does not permit any further analysis of this issue here.

The selection-corrected private rate of return estimates are contrasted in table 3.7 with those based on the ordinary least squares (OLS) estimates for wage earners that ignore the potential sample bias arising from selecting only wage earners. Two selection probit equations predict the probability that the individual is in the labor force and is a wage earner (Catsiapis and Robinson 1982). Both the wage function and the two selection equations vary across regions in Thailand: the least developed Northeast region, the rural population, the suburban sanitary districts, the urban municipal areas, and finally Bangkok. Because regional shifters are specified in the wage function, the private returns to education exclude the gains that accrue to education through the more frequent migration of more educated persons to regions with higher wages.

Table 3.7: Estimates of Private Rates of Return to Schooling in Thailand, by Gender, With and Without Statistical Correction for Sample-Selection Bias

Year--Unit of Earnings (Sample of Earners/Population)	Without Correction[b/]			With Selection Correction[a/]		
	Primary	Secondary	Higher	Primary	Secondary	Higher
I. 1986--Monthly Earnings						
Female	8.2	31.0	9.5	13.0	25.0	18.0
(2,709/8,606)	(4.75)	(18.7)	(4.31)	(7.00)	(9.84)	(5.45)
Male	14.0	18.0	12.0	17.0	6.8	7.8
(4,199/7,685)	(9.40)	(14.4)	(6.81)	(11.3)	(5.34)	(4.61)
II. 1981--Monthly Earnings						
Female	4.6	30.0	2.2	9.0	22.0	12.0
(2,419/8,816)	(2.41)	(19.7)	(.74)	(4.56)	(6.09)	(3.32)
Male	15.0	20.0	4.2	15.0	8.8	2.9
(4,525/7,986)	(10.2)	(17.4)	(1.72)	(9.22)	(6.24)	(1.22)
III. 1981--Hourly Earnings						
Female	5.2	34.0	1.6	10.0	25.0	11.0
(2,419/8,816)	(2.70)	(22.1)	(.55)	(5.00)	(6.77)	(3.04)
Male	16.0	24.0	5.4	14.0	13.0	4.1
(4,525/7,986)	(9.98)	(20.9)	(2.16)	(8.95)	(9.04)	(1.66)
IV. 1976--Monthly Earnings						
Female	11.0	17.0	7.8	11.0	31.0	17.0
(1,464/9,430)	(8.87)	(13.8)	(3.63)	(8.70)	(7.04)	(6.35)
Male	5.7	15.0	8.4	5.6	7.4	11.0
(3,783/8,836)	(6.37)	(16.5)	(5.50)	(5.33)	(7.65)	(6.85)

Note: Double selection correction terms are included in the earnings functions to capture the probability of participation in the labor market and of selecting wage employment See text for identifying restrictions.

a/ The estimation sample is restricted to wage and salary earners between the ages of 25 and 54.

b/ The absolute value of the t ratio is reported in parentheses beneath regression coefficient on years of education within each level of schooling.

c/ The absolute value of the t ratio is reported in parentheses, but it has not been adjusted for the selection correction procedure, and is therefore biased.

Source: Heckman 1979.

For most of this century, Thailand has invested heavily in primary education. Still, it enrolls a smaller proportion of its population in secondary school than do other countries at a similar stage in their development, such as South Korea, Taiwan, the Philippines, and Malaysia, or the two city states of Hong Kong and Singapore (Sussangkarn 1988). On the other hand, the proportion of the Thai population enrolled in higher education is relatively large for a country at its income level. The relative supply of workers by educational level would lead to the expectation that in Thailand the returns to education would be relatively high at the secondary level and

relatively low at the university levels, compared to other countries at Thailand's stage of development.

Primary schooling has been nearly universal in Thailand for some time, and hence the difference by gender is small. The differences between male and female enrollments at the secondary school level are more substantial, but are narrower in the 1975-85 period. Only about half as many women as men were enrolled in Thai institutions of higher education in the 1970s (UNESCO 1984).

As reported in table 3.7 for 1981, for example, without sample-selection correction, women's hourly rates of return appear to be 5 percent a year for primary education, 34 percent for secondary school, and 2 percent for university education. For men, the OLS primary school returns are 16 percent; secondary school, 24 percent; and university education, 5 percent. The statistical correction for the two sample-selection processes that might bias these estimates modifies the estimates markedly in four out of the six cases. Three out of four selection terms are statistically highly significant (Schultz 1989). The return to primary education for women doubles to 10 percent, whereas the returns to secondary school decline for both women (to 25 percent) and men (to 13 percent). Higher education private returns increase to 11 percent for women and decline to 4 percent for men.

The analysis is repeated with 1981 monthly earnings, thereby including labor supply adjustments related to schooling as part of the private market returns. In four out of six comparisons, the selection-corrected monthly returns are slightly lower than the hourly returns. The better educated work fewer hours a month, or enjoy more leisure, responding to education as a gain in their wealth. Exceptions are women at the higher education level and men with only some primary schooling, who increase their labor supply as their education increases. Overall, however, the hourly and monthly earnings data yield similar results for the direction and magnitude of the effect on schooling returns of the correction for sample selection. Only the monthly earnings functions can be estimated from the earlier and later

Thai surveys because respondents were not asked about hours worked during the previous month.

By 1986, male and female returns to primary schooling had increased from 1981, and the correction for sample selection continues to raise these returns for women. At the secondary school level, women's high private returns to schooling are diminished somewhat by the correction procedure, but they are more than three times higher than male returns at this school level. Finally, at the higher education level, private returns are higher for both Thai women and men, though the sample-selection correction has again a greater effect of doubling female returns. Only at the primary school level are the returns to male education greater than those to female education. Going back to 1976, the pattern of schooling returns is roughly comparable. Higher education earned slightly higher returns for men in 1976, 11 percent, compared with 3 percent in 1981 and 8 percent in 1986; the rapid expansion of public "open" universities in this period may have reduced the overall quality of a year of higher education.

Much more work is needed to assess the effect of alternative methods for coping with sample-selection bias as it affects estimates of returns to education of women compared to men. Nevertheless, these data from Thailand spanning eleven years suggest that estimated levels of returns to schooling may be sensitive to this source of sampling bias. The overall tendency is for the sample-selection correction to raise returns to female schooling and lower them to male schooling. With the exception of primary school returns after 1981, women's schooling appears to earn a more favorable return than does men's schooling in Thailand.

An understanding of what underlies an individual's allocation of time is required to correct analyses of wage earners that seek to infer the effect of investments in schooling on the productivity of all people. This sample-selection correction procedure depends on what the relevant family unit is that may pool resources and coordinate labor market behavior, and how these forms of family behavior are modeled. The bargaining model implies a few, possibly useful, differences between the empirical specification of the family

labor supply model and that implied by the unified family demand model. On the whole, however, both models require similar variables for identification of the sample-selection rule determining wage earner status. Conclusions drawn from this section are likely to be robust to changes in how the family decisionmaking process is eventually modeled.

NONMARKET RETURNS TO SCHOOLING

The effects of schooling on market earnings are relatively well documented, although sometimes subject to uncertainty because of problems of measurement and estimation. The evidence on the returns to schooling in nonmarket production within the household is more fragmentary, however, and is inherently difficult to aggregate or summarize in a single measure such as an internal rate of return.

The greater the level of education of married women, the more likely they are to work in the labor market and in wage employment, given their husbands' education and business capital. This pattern has been observed frequently in surveys in low-income countries, particularly in urban areas and in rural areas where off-farm employment opportunities for educated women are reasonably developed. Thus, to work in the labor market, more educated women must curtail their nonmarket production activities or at least find substitutes for their time in nonmarket production.

At the same time, many studies reveal that quantifiable increases in home output occur as women's education increases, despite the fact that they are likely to spend less time in the home. That is, the productivity of women in home production appears to increase as their education increases, indicating that nonmarket returns to schooling are positive.

Determinants of Child Health and Survival

Studies in demography, economics, anthropology, and sociology conclude that a strong inverse relationship exists between a mother's schooling and the incidence of mortality among her children. This relationship is particularly strong in low-income countries. Many hypotheses have been advanced as to why (see, for example, Farah and Preston 1982; Schultz 1984; Barrera 1988). The pattern has been widely replicated across comparative surveys, such as the World Fertility Surveys, and over time based on repeated censuses.

Data that are now widely collected from women in low-income countries on their age, children ever born, and children still living facilitate analyses of the determinants of child mortality. Additional information on the timing of each birth and survival or date of death of the offspring, improves the measurement of the mortality risk faced by each of a woman's children. These refinements are particularly useful in comparing the child mortality experience of younger women. Educational differentials in child mortality are not very sensitive to which of these procedures is used to compare with simple child survival (Preston and Trussell 1982). The statistical strength of the relationship and its replicability across surveys and societies is reminiscent of the "discovery" in the 1960s of the logarithmic wage function, which also depended centrally on education-based differences in wage rates. One is a measure of the market rate of return, the other a form of the nonmarket return to women's education.

An added year of maternal education tends to be associated with a relatively constant percentage change in child mortality rates. Although mortality tends to be higher in rural than in urban areas in many low-income countries, the proportionate reduction in child mortality associated with an additional year of mother's schooling is about the same, between 5 and 10 percent. The mortality-reducing effect of father's education is smaller, especially in rural populations (Mensch, Lentzner, and Preston 1986).

Studies in Latin America have noted that the differentials in child mortality associated with maternal education were more moderate in Costa Rica and Cuba. The hypothesis for these deviations is that these countries' strong public health programs have improved access to health care, even among the least-educated mothers (Behm 1980). Other economic hypotheses for the differences in the relative magnitude of the effects of schooling on child mortality are analyzed by Rosenzweig and Schultz (1982) and are discussed further elsewhere (Schultz 1984; Thomas, Strauss, and Henriques 1987).

Is education simply correlated with the use of more health inputs, or does education provide a mother with the capacity to cope with health risks and better manage her child's environment? An analysis of the 1973 census in Colombia indicated that controlling for household income, husband's education, or the marital status of the mother did not eliminate or even greatly reduce the independent role of the mother's education as a partial explanation for her children's survival (Schultz 1980b). Studies elsewhere have shown that although controlling for many lifetime events and changes in socioeconomic status in relation to child mortality rates is possible, the mother's education still had a substantial effect (Farah and Preston 1982). In Brazil, a third of the mother's education effect on child mortality could be explained through controls for family income variables (Thomas and others 1987).

In addition to influencing child mortality, a mother's education undoubtedly influences many intercorrelated variables such as migration, labor market behavior, use of health care, and modern attitudes. Controlling statistically for these types of variables is, therefore, likely to result in an understatement of the net effect of schooling (Mensch, Lentzner, and Preston 1986).

The puzzle that remains is why a mother's education explains more of the variation in child mortality than do other variables such as an individual's access to health care, the prices of health care, or even total family income that could be spent on health care? Three competing hypotheses are that (1) the better educated mother uses a different mix of observable health inputs; (2) she uses these inputs more effectively, or (3) her

education is positively correlated with the use of many minor health inputs that are not observed, and her education is credited with the effect of these unobserved inputs on child health (Schultz 1984).

The most important health worker for children is their mother. How well she performs this task depends "on her schooling, which equips her with general and specific knowledge, and the means and confidence to seek new ideas" (Barrera 1988). How does education influence the use of health inputs to reduce the probability of child mortality? The answer is sought by studying the variations in more continuous indicators of child health status that can be measured through surveys, including the child's height and weight at birth. Anthropometric indicators predict lifetime health problems and mental and physical development handicaps accurately, as well as subsequent age-specific mortality. Further, the health care used by pregnant women has been analyzed to evaluate the effect of this input on the "production" of child health (Schultz 1984). Selection of some health inputs occurs in response to the mother's expectation of a good or poor birth outcome. Consequently, the simple correlation between these forms of self-selected health care and health outcomes can be biased or misleading. For example, prenatal care is sought from a doctor early in difficult pregnancies; such early prenatal care is thus not surprisingly correlated with having a less healthy and lower than average weight of the child at birth. But early prenatal care is nonetheless beneficial for an average women or for a mother and child whose initial health condition can be statistically held constant. In this United States study, the effect of the mother's education on birthweight is transmitted largely through the variation in four measured prenatal health inputs: age, parity, smoking, and timing of prenatal care (Rosenzeig and Schultz 1989). The effect of maternal education on child helth in this case is fully explained by education's effect on the use of observed health inputs.

The inputs that play a major role in producing good nutrition, good health, sound development, and survival in an older child are more difficult to measure. A statistical explanation must also be found for which mother

uses each of these health inputs, if their effect on the production of child health is to be estimated without a self-selection bias.

Impact on child health of maternal education, health care facilities, and interactions between mother's education and her constraints in caring for her children's health may be simpler to examine directly. Estimates of the health effects of these interactions document how maternal education exerts its elusive effect on child health. For example, Caldwell (1979) hypothesized that in West Africa, a mother's education enabled her to exploit local public health care more effectively. He suggested that the interaction between mother's education and local public health infrastructure was complementary or positive: more educated mothers gained most from local public health clinics. According to his hypothesis, differentials in child health or mortality, by mother's education, should increase in communities served more intensively by a public health system. Rosenzweig and Schultz (1982), however, found the opposite pattern of negative interactions or substitution in Colombia. There differences in maternal education had a smaller impact on child mortality in urban populations that received more public and private hospital and clinic services per capita. Their findings can be viewed as consistent with the aggregate patterns reported in Latin America by Behm (1980) and Palloni (1981) and in Sri Lanka by Meegama (1981).

Other studies have examined the relationship between mother's choices of health inputs and environmental constraints on child mortality. In Malaysia, among those households with poor water and sanitation facilities, breast-feeding was associated with reductions in child mortality (Butz, Habicht, and DaVanzo 1984). Estrey and Habicht (1987) found that safe water supplies reduced child mortality by a greater amount for more educated than for less educated mothers, whereas access to toilets in the household was less effective in reducing child mortality in the case of educated mothers. In Costa Rica, Haines and Avery (1982) found that an additional year of a mother's education reduced her children's mortality 6 to 7 percent, holding constant household sanitation, quality of the dwelling, and community child mortality levels and health care facilities. Haines and Avery concluded that the child health gains related to mother's education were smaller in urban

areas, a result also found by Schultz (1980b) for Colombia and by Behm (1976) for several Latin America capital cities. Similar studies for Malaysia and Costa Rica treated the household water and sanitation infrastructure, as well as the mother's breast-feeding, as exogenous, in other words, as not affected by maternal education or unobserved variables that might themselves have otherwise influenced child health outcomes.

Barrera's study (1988) of household and community data from the Bicol Province of the Philippines refined these earlier studies. He assumed that the water and sanitary facilities of households were endogenous choice variables that may be correlated with unexplained variations in child health. He first analyzed the relation between maternal education and child health, conditional on the community's average levels of water and sanitation but not on the household's actual variables, which are assumed to be spuriously correlated with the family's other choices. Barrera found that mother's schooling had a larger protective effect on child health in unsanitary communities where signs of excreta were visible and in communities that were farther (in time) from outpatient health care facilities. In a community where piped water was the predominant source of supply, the impact of mother's education diminished. Where water-sealed toilets were more prevalent in the community, the differences in the effect of maternal education on child health were larger. Because Barrera replaced household-level measures of water and toilet facilities by community-level ones representing the local availability of these facilities, he obtained conclusions that were diametrically-opposed to those of Estrey and Habicht (1987): the community water supply appeared to substitute for mother's education, while modern toilets complemented it (Barrera 1988; table 16). At the same time, Barrera showed that higher income and mother's education increased the chances that a household had acquired piped water and water-sealed toilets.

The duration of breast-feeding, another important input to child health, is inversely related to mother's education in many countries (see, for example, Blau 1984; Wolfe and Behrman 1982). Table 3.8 illustrates how in Africa, Latin America, and Asia, women with seven or more years of schooling

tend to breast-feed their children seven or eight months less than do women with no schooling.

Breast-feeding is beneficial to child health primarily when it is supplemented by other foods before the end of the baby's first year. In Barrera's rural Philippine population, mother's education shortened only the duration of unsupplemented breast-feeding (1988, table 23). Moreover, he estimated that unsupplemented breast-feeding was "beneficial" only up to six months. The more educated mother can also replace her milk with more sanitary substitutes. For the less educated, Barrera hypothesized, supplementation of breast-feeding at less than six months was harmful. Thus, the optimal duration of breast-feeding and the optional time to introduce supplementary foods in the child's diet depended on the education of the mother who had to provide sanitary substitutes for her own supply of milk. In sum, the duration of unsupplemented breast-feeding and education appeared to be substitutes in their effect on child health. This finding may partially account for why more educated mothers breast-feed less, but their children's health is better (Barrera 1988, table 25).

Determinants of Child Achievements in School

Surprisingly few studies have addressed the household determinants of school enrollment and attendance rates by gender in low-income countries. In an analysis of district-level data from the Indian census of 1961, Rosenzweig and Evenson (1977) found that where child wages were higher, children supplied more labor to the market and enrolled less in school. Male wage rates were negatively associated with child schooling levels, while female wages were positively associated with enrollment rates. Their model implied these partial effects of wage rates on children's schooling, but only after a number of cross-commodity substitution patterns were imposed and price (wage) effects were assumed to outweigh income effects. At the individual level, data often show the father's education to be a stimulus to the child's achievements in school.

King and others (1986) estimated from several Asian surveys the determinants of parents' investments in schooling for their sons and daughters. Analysis of schooling decisions in greater detail, based on a Peruvian survey, permitted an analysis of whether parents invest by sending their children away to continue their schooling, generally at a private versus local public school. A review of the schooling decision suggests that both access to a community school and family income increased enrollments, particularly for girls (King and Bellew 1988; Gertler and Glewwe 1988).

In most studies of the schooling of children in high-income countries, the mother's education has a larger effect than the father's, even though the father's education implies a larger market income effect because he tends to receive a higher wage and to work more hours (Leibowitz 1974; King and others 1986). Evidence that the mother's schooling exerts a greater effect on the schooling of daughters than sons is less well established (see, for example, de Tray 1988: table 5). That hypothesis requires further study.

Determinants of Fertility

More educated women marry later, as shown in table 3.8 for the countries included in the World Fertility Surveys. In Africa, women with seven or more years of schooling tend to marry five years later than do women with no schooling; the differential is about three years in Latin America and Asia. Table 3.9 examines how median age at first birth varies by a woman's education in eight African countries, with further disaggregation by age of the woman. The effect of female education on the age when a woman's child-bearing begins is not uniform across Africa, but it is of growing importance in such countries as Kenya and Ghana, where overall fertility levels may soon begin to decline.

Table 3.8: Women's Average Age at Marriage, Breast-feeding, and Contraception by Region and Education, for World Fertility Survey Countries

Region (Number of Countries), Years of School Completed	Age at Marriage[a/]	Breast-feeding[b/]	Contraceptive Usage[c/]
Africa (8 to 12)			
0 years	17.8	19.9	7
1-3	19.2	18.5	14
4-6	20.3	15.7	17
7 or more	23.0	13.4	27
Difference (7^+-0)	5.2	-6.9	20
Latin America and Caribbean (13)			
0 years	19.5	15.0	24
1-3	19.5	12.1	33
4-6	20.4	9.1	43
7 or more	22.6	5.4	53
Difference (7^+-0)	3.1	-8.7	29
Asia and Oceania (7 to 13)			
0 years	20.2	20.1	16
1-3	19.5	18.4	26
4-6	20.6	16.0	28
7 or more	23.8	10.6	39
Difference (7^+-0)	3.6	-7.1	23

a/ Singulate mean age at marriage in years.
b/ Mean duration of breast-feeding in months using current status estimates based on surviving births only using life table methods.
c/ Percent of currently married women aged 15-49 currently using contraception, adjusted for age differences between education groups.

Source: United Nations (1987), tables 119, 121, and 122.

Table 3.9: Median Age of Women at First Birth by Age and Education, Selected African Countries

Country, years of schooling completed	Age		
	Younger Than 25	25 to 34	35 or Older
Senegal			
0 years	18.3	18.0	17.9
1 - 4	19.3	(18.6)	(19.6)
5 - 7	19.7	20.4	(21.0)
8 +	22.4	(23.0)	(23.0)
Difference (8-0)	4.1	5.0	5.1
Ghana			
0 years	18.9	19.3	20.0
1 - 4	18.6	19.7	20.3
5 - 7	18.8	20.2	19.3
8 +	20.5	20.7	20.5
Difference (8-0)	1.6	1.4	0.5
Lesotho			
0 years	18.7	19.5	22.2
1 - 4	19.1	19.9	(19.8)
5 - 7	19.8	20.5	(21.1)
8 +	20.8	22.9	22.8
Difference (8-0)	2.1	3.4	0.6
Benin			
0 years	19.5	19.1	19.7
1 - 4	19.4	19.9	(19.8)
5 - 7	19.3	19.7	20.7
8 +	20.2	21.2	21.0
Difference (8-0)	0.7	2.1	1.3
Kenya			
0 years	18.2	18.4	19.4
1 - 4	18.6	18.2	19.3
5 - 7	19.1	19.3	19.2
8 +	21.3	20.5	(21.5)
Difference (8-0)	3.1	2.1	2.1
Cameroon			
0 years	18.2	19.3	20.6
1 - 4	18.4	18.8	19.7
5 - 7	19.0	19.0	19.1
8 +	21.4	20.6	(24.3)
Difference (8-0)	3.2	1.3	3.7
Ivory Coast			
0 years	18.3	18.7	19.3
1 - 4	17.6	19.2	20.2
5 - 7	18.2	18.7	19.9
8 +	20.2	18.8	20.2
Difference (8-0)	1.9	0.1	0.9
Sudan			
0 years	18.0	18.5	20.0
1 - 4	17.6	18.6	20.1
5 - 7	19.1	(19.6)	(21.0)
8 +	(20.3)	21.6	(23.6)
Difference (8-0)	2.3	3.1	3.6

Note: Means reported in parentheses are less reliable because they are based on fewer that 50 observations in the specific age-education category.

Source: World Fertility Surveys as tabulated by Eelens and Donne (1985), tables A.9-A.16.

The countervailing effects of decreased breast-feeding on fertility as mother's education increases (table 3.8) may remove a month or so from the interbirth intervals of the most educated mothers (related to breast-feeding seven to eight months less). The much greater prevalence of contraception among the more educated women (table 3.8) more than fully compensates in its impact on fertility for this shorter duration of breast-feeding.

As shown in table 3.10, total fertility rates are lower for women with seven or more years of schooling compared to those with no schooling. The differences by women's education are larger in Latin America (-3.6 children), than in Africa (-2.0 children) or Asia (-3.1. children), but they are relatively uniform regardless of fertility measure.

Table 3.10: Measures of Recent, Cumulative, and Desired Fertility: Averages for World Fertility Survey Countries Reporting, by Region and Respondent's Education

Regions (Number of Countries) Years of Schooling Completed by Women	Total Fertility Rate[a/]	Marital Fertility Rate	Children Ever Born[b/]	Desired Family Size[c/]
Africa (8 to 10)				
0 years	7.0	6.6	6.4	6.9
1-3	7.2	6.6	6.5	6.4
4-6	6.2	6.3	6.1	5.9
7 or more	5.0	5.4	4.8	5.0
Difference (0-7+)	-2.0	-1.2	-1.6	-1.9
Latin America (13)				
0 years	6.8	6.8	7.1	4.8
1-3	6.2	6.2	6.8	4.7
4-6	4.8	5.2	6.0	4.2
7 or more	3.2	3.8	4.2	3.7
Difference (0-7+)	-3.6	-3.0	-2.9	-1.1
Asia and Oceania (9 to 13)				
0 years	7.0	6.6	6.7	5.4
1-3	6.4	6.4	6.7	4.3
4-6	5.8	6.1	6.4	4.2
7 or more	3.9	4.7	4.9	4.0
Difference (0-7+)	-3.1	-1.9	-1.8	-1.4

a/ Age standardized.
b/ Age 40-49 years.
c/ Age adjusted.

Source: United Nations (1987), table 112 and 115.

If one holds constant for marital status, or essentially age at first marriage, (marital) fertility differences by education are about a third less than differences in total fertility in Africa and Asia, but they are only 20 percent less in Latin America, where overall contraceptive prevalence is high but varies greatly by woman's education. To compare children ever born, the figures are restricted to the age group of women who have completed their childbearing (ages 40-49). These data are not informative, therefore, on reproductive patterns among younger women or recent trends.

The last aspect of fertility measured through the World Fertility Surveys is women's desired family size. Desired fertility also falls monotonically with a woman's education. Subtracting the desired fertility from the current total fertility suggests that the potential for increased contraception to reduce fertility toward desired levels is concentrated among women in Latin America with less than four years of schooling and in Asia among women with less than seven years of schooling. Among the better educated women, total fertility rates are already approaching desired fertility levels. This reflects of the fact that women's education substitutes for family planning by helping women reach their desired reproductive goals (Schultz 1989).

Other studies also indicate that women's education helps couples to avoid exceeding their reproductive goals. This is partially achieved by delaying marriage (Cochrane 1979), but more educated wives also have fewer unwanted conceptions and births in marriage (Rosenzweig and Schultz 1985 and 1987). Although the husband's education may also enhance the effectiveness of contraception, the wife's education has at least as strong an effect on these forms of reproductive behavior, whether inferred from a respondent's own classification of conceptions as unplanned or derived from econometric analyses of the reproduction function and its residual (Rosenzweig and Schultz 1985, 1987, and 1989). Reduced fertility may be another sphere of nonmarket production in which the education of women generates an important beneficial social externality.

Although fertility during a woman's lifetime appears to decrease as her education increases, in some cases the fertility of unschooled women is slightly lower than that of women with one to three years of schooling (see African region total fertility rates in table 3.10). This occasional reversal in fertility differentials by women's schooling has two interpretations. Easterlin (1975) proposed a framework for describing the demographic transition that accommodates the tendency for birth rates to increase at the outset of modern economic growth before birth rates begin their secular decline. This early rise in fertility has been attributed to improved

maternal health and decreased breast-feeding, both thought to increase reproductive potential before contraception was available and widely used. The rise in fertility among women with a few years of schooling could, therefore, be attributed to the enhanced reproductive potential of women who receive only a couple years of schooling (Cochrane 1979 and 1988).

The second explanation for this occasional reversal in the fertility differential associated with a few years of women's schooling relies on the household economic model of fertility. Economic models of family decisionmaking focus attention on the potentially different signs of the effects of men's and women's schooling (or value of time) on their demands for children and hence lifetime completed fertility (Schultz 1981). These differences in wage effects on fertility, by source, follow from the customary tendency for women to spend more time in child care activities than do men. This economic household demand model of fertility helps to account for the observed tendency in multivariate analyses for female education (or wages) to be inversely related to fertility, while male education (or wages), land or asset income, and child wages are all directly related to fertility, at least in a traditional agrarian society (Schultz 1973). At a later stage in the development process, the fertility effect of male education (wages) may also become negative because the parents invest more heavily in the schooling of their children.

Thus, the simple one-way correlation between women's education and their fertility can be a misleading indicator of education's effect. To estimate the relevant <u>partial</u> effect, one must hold constant statistically the other major exogenous determinants of fertility. The bias caused by omitting these other determinants, in the case of men's education (or wages), is undoubtedly to reduce the estimated negative effect of women's early schooling, because the years of schooling of husband and of wife are strongly positively correlated in all societies, and men's education (or wages) is often positively related to fertility, at least at low levels of education.

All these routes by which women's education may improve society--reduced child mortality, enhanced child nutrition, increased child schooling,

and reduced fertility--involve benefits that are partly captured by the women's own children. If parents are entirely altruistic toward their offspring in a dynastic form of intergenerational family and they thus view their children's utility as identical to their own, these nonmarket activities of women would be adequately encouraged within the family.

Parents may not view sons and daughters as equally important branches of the family, however, or their perceptions of the payoff to education may be based only on education's effects on wages in the labor force. Many societies have strengthened the rights of children and weakened the economic claims parents can place on their children--for example, through restrictions on the conditions of child labor, mandatory school attendance, and penalties for truancy. Also, many societies link improvements in women's education to increases in the level of investment in the human capital of children (Thomas 1989). A subsidy that favors women's schooling would help shift private household resources toward investments in the quality of the younger generation. Empirical studies have not yet widely appraised how responsive families would be to practical interventions that seek to educate women in order to increase their investment in the human capital of their children, but some development projects are testing these linkages (Martin, Flanagan, and Klenicki 1986).

SOCIAL RETURNS TO SCHOOLING AND EXTERNALITIES OF EDUCATION

The social costs of schooling are traditionally calculated by adding public expenditures on education to the private opportunity costs of the time of students. Hence, the social returns to education are lower than the private returns, often by 20 to 30 percent. This adjustment should not cause the returns to educating women and men to differ, unless the public resources devoted to teaching women and men differ. In many parts of the world, higher education for women is focused on specific professions, such as teaching and nursing, which may be less costly to provide than other curricula. For example, women in some countries receive much of their higher education in "normal schools," which cost less per student per year than regular academic institutions (see, for example, Birdsall and Fox 1985). This pattern is also

noted in India (Tilak 1987). Given higher costs for educating men, the social returns from their schooling should be commensurately lower. Much better data are needed on these differential costs, however.

If a government taxes labor earnings, it reduces private returns to human capital and recovers some of its expenditures on education, health, and other public services. In most low-income countries, however, only wage and salary workers are effectively taxed, and no country has designed a tax on nonmarket production.[35/] The tendency for more men than women to work for a wage and be taxed might appear to favor social investments in the schooling of males over females. This supposition, however, depends on how the labor supply of men and women responds to the market wage offered to them (after taxes). Most empirical studies of labor supply in high- and low-income countries indicate that women respond positively to an increase in their own market wages and negatively to an increase in their husbands' wages. Consequently, the taxable supply of women's labor rises with an investment in women's capabilities and decreases with a comparable investment in men's capabilities. Moreover, estimates of the male labor supply often reveal a

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35/ Taxes on personal income are a relatively small portion of government revenues in low-income countries. The exception may be Latin American if one includes "social security" taxes (World Bank 1988a, p. 84) In the case of Thailand in 1981, direct taxes on personal incomes amounted to less than 5 percent of household expenditures, and only 10 percent of expenditure for wage recipients in Bangkok (National Statistical Office, undated). Most of government revenues in low-income countries are from trade and excise taxes on companies and commodities. Thus, adjusting for taxes may be of secondary importance in many low-income countries, but it could be quite important in industrially advanced countries and moderately important in Latin America.

tendency for men to reduce their labor supply as their own wages rise.[36/] Thus, to the extent that governments recoup public expenditures on investments in human capital by taxing wages, the social return from investing in women should be greater than that from investing in men.[37/]

A more widely accepted rationale for public expenditures on education for both men and women is that an educated population enjoys a higher level of welfare. Moreover, this gain is not entirely captured by more educated individuals or their families. That human capital may be a source of increasing returns helps to explain the puzzle of modern economic growth (T.W. Schultz 1988; Kuznets 1966).

Supporters of public education may also argue that a more educated society is more capable of managing a political system that protects individuals' rights and facilitates efficient and equitable growth. Although these claims are difficult to substantiate, more concrete examples have been empirically confirmed. As noted earlier, most favor the schooling of females.

36/ The marginal tax revenue, dR, generated by the expansion of education for women, E_w, and men, E_m, can be expressed as follows:

$$dR/dE_w = tw_w\alpha_{1w}\ (ß_{1w} + ß_{2m})$$

$$dR/dE_m = tw_m\alpha_{1m}\ (ß_{1m} + ß_{2w})$$

Where α_{1m} and α_{1w} are the private rates of return to schooling of men and women, which are assumed equal; $ß_{1w} > 0$ is the wife's uncompensated own wage effect; $ß_{2w} < 0$ is the wife's uncompensated husband's-wage effect;, $ß_{1m} \leq 0$ is the husband's uncompensated own-wage effect; and $ß_{2m} \cong 0$ is the husband's uncompensated wife's-wage effect. The above indicated signs are those commonly obtained in static instrumented family labor supply models (Cogan 1980; Schultz 1981).

37/ A parallel public finance argument can be made for taxing more heavily inelastically supplied factors, if the goal is not to distort the optimal (that is, untaxed) allocation of factors. This tax criterion implies that, given the labor supply parameters outlined in footnote 10, male labor outcomes should be taxed more heavily than female labor outcomes because they are inelastically supplied.

CONCLUSIONS AND DIRECTIONS FOR RESEARCH AND POLICY

Investments that increase the primary and secondary schooling of women are economically warranted on several grounds, based on the currently available evidence from many countries. The public and private direct and opportunity costs of schooling appear to be recovered fully by the increased market productivity or potential wage gains experienced by better educated women during their adult lifetimes. When internal rates of return are calculated based on private costs of attending school and potential wage gains, the returns tend to be at least as high for women as they are for men, varying from 30 to 10 percent in the less and more developed countries, respectively (Psacharopoulos 1973 and 1985).

Social rates of return calculated to recoup public expenditures on education are fractionally lower than private returns at the primary school level. The social returns to higher education are in some instances markedly lower than private returns, because of the relatively high costs of university training in low-income countries, including the opportunity value of students' time. In some cases, the public sector even pays for these opportunity costs by providing scholarships and cost-of-living stipends regardless of the financial need of the student (World Bank 1986a).

Although public expenditures on education are rarely disaggregated by sex, the public costs of education are likely to be lower for females than males. If so, the social returns are correspondingly higher for females than males, at least at the university level, when other things are equal.

Evidence is accumulating that schooling increases the nonmarket productivity of women. For example, a mother's education can improve her children's health, measured by their birthweight, nutritional status, and the absence of morbidity and mortality. Research surveyed earlier describes how maternal education produces these child health benefits. Studies that estimate the interactions between maternal education and program and policy interventions confirm that in some circumstances public health and family planning programs provide services that appear to substitute for maternal

education (Schultz 1984). The largest payoff in terms of nonmarket returns to maternal education are realized where public health and family planning programs are least developed. Differentials in child mortality by mother's education are smallest, therefore, in urban areas served by relatively well-funded public health programs, and they are largest in rural areas that generally lie outside of the reach of hospitals and public health and family-planning clinics.

The education of a woman is also associated with the educational achievement of her children, her fertility, and her regional and occupational mobility, controlling for her other household resources and productive opportunities. Though less widely studied than the linkage between female education and child health, these parallel relationships also confirm the importance of female education to nonmarket productivity. For the most part, the woman and her family capture these returns, which thus compensate the intergenerational family for the costs of her education. The nonmarket returns to women's education may also represent a social externality, however, and therefore warrant special public subsidy insofar as society at large benefits from reduced fertility, diminished population growth, improved health and education of children, and increased population mobility.

Investments in the schooling of women encourage a shift in the allocation of women's time toward market work and away from home-based work. Market-based work is counted in conventional national income accounts--and hence adds to GNP--whereas home-based work is not. But this is no reason in itself to encourage female education. This shift in the allocation of women's time may have other desirable consequences for the productive use of social resources. For example, because better educated women are more likely to work in wage employment than are less educated women, they tend to pay more direct and indirect taxes. Increases in men's education that contributes to increasing their wages, tend to reduce the number of hours their wives work in the market labor force, and frequently, the men themselves work fewer hours as well. Thus, social rates of return on women's education are, higher than those on men's education, because the women's education returns more in taxes to support public schooling.

Education and Fertility

Social scientists and statisticians studying child mortality and fertility have used very different methods to estimate these relationships. Unless the common core of major exogenous economic variables is held constant, findings on the partial effects of women's education on child mortality and fertility will be unstable and potentially misleading. Any focused literature survey in these fields requires a clearly articulated research methodology.

Although parents universally prefer a reduction of child mortality, there are times when couples do not want to limit their fertility. The effect of a variable, such as mother's education, on fertility involves both its effect on desired fertility (if birth control were costless and perfectly reliable) and its effect on unwanted fertility (by reducing the cost of using birth control with less uncertainty). Therefore, surveys of the relationship between education and fertility that do not control for the economic resources available to a woman from her husband and from nonearned family income and for the relative benefits and costs of children, do not always find a monotonic inverse relationship between female education and fertility. Use of the economic household demand model of fertility should make assessments of this important aspect of fertility variation across low-income countries more uniform.

Regional and Occupational Stratification

Returns to education are sometimes calculated within subpopulations. If these subpopulations are defined by characteristics that are fixed for individuals, such as sex, race, or caste, interpretation of the returns within each strata is straightforward. If the subpopulations are not closed, however, as in the case of regions or occupations, empirical estimates of within-group returns to education are ambiguous and potentially misleading.

More educated individuals, male or female, are more likely than the less educated to migrate from one region to another, holding constant

differential wage gains earned by migration (Schwartz 1976). For example, estimation of the returns to schooling within a declining sector, where wages are generally lower than elsewhere, is likely to introduce a downward bias to estimates of the returns to schooling. This occurs because part of the return to schooling in the declining sector involves migrating out of that sector. Consequently, rural-urban stratified estimates of educational returns are potentially misleading unless the strata can be defined by birthplace or residential area where the individual attended school. If migration rates differ for men and women, this bias in estimating the returns to education within a sector may distort the estimated returns to schooling for women relative to those for men.

For the same reasons, assessing the returns to schooling among the self-employed is difficult. In the rural sector, the self-employed tend to be landholders or tenants, and in the urban areas, small businessmen. The probability of being self-employed increases generally over the life cycle in low-income countries, and therefore wage functions estimated across ages, but within such an occupational group, are not readily interpreted in the human capital life-cycle framework (Mincer 1974). The assessment of labor market returns to schooling may be more accurate if analysis is restricted to wage earners, whose wage rates approximate hourly productivity. Such an analysis must then be corrected, however, for the systematic bias introduced because only wage earners remain in the sample. A joint analysis is required of the individual's occupational choice or allocation of time and the determinants of market wage productivity. This is again the now-familiar problem of correcting for sample-selection bias, which has emerged repeatedly in this paper as a major limitation to existing research on returns to schooling of women.

To evaluate the resource intensity of the educational process, more detailed information is needed on the amount of time students and teachers expend on it. For students, the resource input is the private opportunity cost of the student's time allocated to school attendance and school homework. For teachers, it is the teacher's input or time, adjusted perhaps for the number of students he or she teaches in a class and for the amount of time

required for preparation of class material. These school inputs may differ for female and male students, though they are both enrolled in the same level of a school system. More accurate measures of the private and social costs of a year of school enrollment for males and females in distinctive branches of the educational system might help explain subsequent differences in their adult productivity and might modify resulting estimates for the private and social returns to schooling for women and men.

Increasing Female School Enrollment

Available evidence indicates that schooling for women is justified in terms of efficiency (high market social returns), equity (an increase in the capability of the poor relative to the rich), and intergenerational redistribution (better health and education of children and slower population growth).

Why then does the shortfall in female education relative to male education persist in South and West Asia and in North and Sub-Saharan Africa? Part of the answer undoubtedly lies in the family decisionmaking process that attaches less value to the future productivity of daughters than to that of sons. Parental claims on the adult productivity of boys may be more secure in some family-cultural systems than their future claims on girls. The public-sector school incentive structure may also subtly encourage males more than females to remain in the school system. If parents' allocation of school investments between boys and girls does not lead to a socially optimal intergenerational pattern of investment in human capital in some countries, what should be the role of public policy? The inefficient allocation of resources, even if we do not know the precise cause, can frequently be corrected by a judicious application of taxes and subsidies, but few studies have isolated policy changes that have a clear impact on female enrollment rates (Martin, Flanagan, Klenicki 1986).

Much economic research on the family assumes that it behaves as if it had unified preferences and pooled its economic resources. This model explains how the family should make production decisions but does not

prescribe the factors affecting consumption patterns within the family, or who receives education. Another approach to the unified family demand model is one that explicitly recognizes the distinct interests of husband and wife and explores how bargaining might influence the allocation of time and resources within the family. Research is only beginning to consider across cultures how game theory might illuminate critical family decisions that affect levels of health, nutrition, and educational resources invested in girls and boys (Schultz 1989).

General development processes contribute to increases in per capita income and to reductions in the relative cost of teachers. Both of these factors contribute to increasing school enrollment rates and reducing the imbalance between female and male enrollment rates (Schultz 1987). Beyond these general factors, how educational services are produced and delivered also probably affects the male and female mix of enrollments. Evaluation is needed to assess what reforms in the school system are cost-effective approaches to closing the gap between the socially desired gender mix of human capital investments and the mix now being privately demanded and publicly provided.

Because parents may be more willing to send a son than a daughter to a distant school, making small-scale, community schools available may be more important for raising female enrollment rates than is improving quality of the schools by consolidation, if that involves longer travel times for students. Parents may prefer that their daughters be instructed by female teachers and may be more willing to send their daughters to school if the school preserves a degree of traditional sex segregation in facilities. Research, however, has seldom sought to measure how variation in school facilities, staffing patterns, location, and sex segregation influence parents' decisions to send their daughters or sons to school, holding constant at least the parents' income and education. Such analysis must be conducted at the household level on the basis of random household surveys and must encompass a substantial number of communities pursuing different educational policies.

To educate their children, parents must be willing to forego the home labor of their children while they attend school. Many studies confirm that teenage daughters work more in the home than do sons (Evenson 1983). In addition, when family members become ill and need special attention at home, it is teenage daughters that are held back from school to provide this home care (Pitt and Rosenzweig 1988). If means were found to reduce the household's dependence on the home labor of teenage daughters, would their enrollment in school increase? The decline in fertility that is facilitated by family planning programs may reduce demands on daughters to care for younger siblings in the home. Improved home production technology and market services could additionally reduce the demand for child labor in the home, and disproportionately benefit daughters who perform more than their share of such tasks. Improved water supplies; reduced fuel requirements of modern stoves; increased specialization of firms and families, which would permit food processing and storage to become market-purchased inputs to the household, would all reduce the reliance on home-produced, child labor-intensive activities.

The situation of women varies widely within and across countries. The challenge is to set priorities that have the highest probability of increasing female enrollment rates in each specific society. Because the direct and indirect effects of many of these programs are uncertain in such varied circumstances, collecting baseline and longitudinal data on populations served by pilot and test programs and new policies is particularly important. Such data would permit future evaluation of program consequences on the educational attainment of women; on the productivity and behavior of women and men; and on the welfare of their families, communities, and countries.

Response to Lags in the Perception of Parents

Parents appear to be responding to the growing evidence in the developing world that more educated sons and daughters get distinctly better jobs. Generally, they will earn more than enough to justify the sacrifices parents make to send them through school. Microeconomists have amassed enough

supporting evidence on wage differentials to provide a human capital explanation for the growth in school enrollments in most low-income countries.

Quantitative assessment of how better educated mothers create healthier children who have a greater chance to survive to adulthood is more difficult. Appraisal of the effect of maternal education on child nutrition, cognitive development, and school achievement is still more subtle. The majority of parents may not yet fully appreciate these complex and extended lifetime relationships, indeed, social scientists do not yet fully understand them either. Even if the current clues in the literature are confirmed by new, more thorough analyses and surveys, parents may still require some time to digest and act on this new body of evidence.

How will this information, as it diffuses through society, tend to affect behavior? Young men, encouraged by their parents, should become more willing to "pay" more, or sacrifice their interests to a greater degree, to marry a more educated woman. This will occur even when a wife is not expected to work in the labor force. As this increased demand for the nonmarket productivity of educated wives becomes apparent, parents may also perceive the monetary and psychological gains they will receive by investing more heavily in the schooling of their daughters.

The historical record has not yet been adequately analyzed, but the nonmarket productivity gains associated with women's education may be a relatively recent phenomenon in some parts of the world. In the past, when effective modern health inputs, such as antibiotics, vaccines, and oral rehydration salts, were not readily available to low-income populations, the ability of a more-educated mother to shelter her child from health risk may have been much more limited than it is today. Modern inputs to home production activities may be especially useful to better educated women. The better educated woman today can control her reproduction with greater ease and certainty than was possible in the past, because of the widening range of birth control techniques. Nonetheless, until more women participate in the paid labor force, parents may persist in their belief that the education of their daughters is of secondary importance to that of their sons.

The resulting allocation of resources is viewed today as uneconomic, but existing policy research has not addressed the question of how governments might compensate for this traditional bias. What policies should be encouraged on the basis of the accumulating evidence that the market returns to schooling of women are at least as high as those of men, and that nonmarket productive returns to women's education are associated with major social externalities--in child health, nutrition, schooling, and fertility--which many societies want to subsidize. Higher quality research in a wider variety of settings could bolster the case for policy interventions. Development agencies should initiate pilot programs and experimental policy tests now, to begin identifying promising, cost-effective policy options. Even, before the pilot programs can be fully evaluated, however, governments can be involved in the evolution of research that documents the local returns to women's education, both in labor market wage differences and in nonmarket productivity gains.

APPENDIX TO CHAPTER III: MODELS OF THE EDUCATION-PRODUCTIVITY RELATIONSHIP[38/]

A positive relationship between the schooling of workers and their earnings is observed in household surveys and censuses in many countries (Psacharopoulos 1985; Blaug 1976). This empirical regularity was first examined in high-income countries, such as the United States, and then described for many other countries. The conventional economic interpretation is to assume wages measure labor's marginal product and that people acquire education, as they do vocational training, at the cost of foregone labor market opportunities, which will be repaid by future streams of enhanced earnings. The emphasis given to monetary returns to education does not preclude the private and social importance of nonmarket production returns to schooling or, for that matter, the pure consumption benefits of schooling. The early focus on labor market returns reflected the availability of data and the historic reliance of economists on the marketplace to measure value by the effect on the national income accounts.

The treatment of education as a form of capital investment embodied in the human agent can be traced back at least as far as Adam Smith, though it enters into the mainstream of economic thinking in the 1950s and 1960s in the work of T.W. Schultz (1961) and Becker (1964). The empirical relationship of wages and schooling is conceptualized as a life-cycle regularity or age-wage profile, with the wage increasing first in the cross-section with the age of the worker and then decreasing beyond some age, when depreciation of productive skills outweighs new investments in human capital. Mincer (1962) proposed human capital investments on the job after the completion of schooling as an explanation for the age-earnings profile. By assuming that post-schooling human capital investment declined regularly with the worker's accumulation of labor market experience and that human capital investment eventually ceased as retirement approached, Mincer (1974) was able to account for many interrelated aspects of earnings for males in the United States, by schooling and by post-schooling experience.

38/ This appendix is derived from Schultz 1988.

These basic empirical regularities are summarized in the earnings function. This relationship has many interpretations, however, depending on what factors generate the relationship (Rosen 1977). Assume that the real wage, w, of a worker is a function of that individual's years of schooling, s, and other productive characteristics, z, such as ability; that is,

$$w = f(s,z), \tag{1}$$

where z is assumed exogenously given to the individual, while hours of work, school quality, and nonschool investments in productive marketable skills are initially ignored. If the private cost of schooling to the student or family is approximated by the full-time opportunity cost of the student's time not spent working in the labor market, then the present value, V of the individual's future earnings can be evaluated at the age of entering school as,

$$V(s,z) = \int_s^n w(s,z)^{-rt}\, dt = W(s,z)(1/r)(e^{-rs} - e^{-rn}), \tag{2}$$

where n is the number of years between the time the individual enters school and then retires from the labor force and ceases to benefit from education. If the internal rate of return to additional schooling falls with increased schooling, and the discount rate or financial constraint, r, does not vary across schooling levels, then the family or individual continues to invest in schooling until the present value of the individual's earnings is maximized. The optimal level of schooling is that which equates the opportunity costs of attending school (that is, not working) to the discounted value of the lifetime gain obtained from the increment to schooling, adjusted for the finiteness of the working life; that is,

$$w_s = wr\left(1 - e^{-r(n-s)}\right), \tag{3}$$

where w_s is the partial derivative of the wage with respect to schooling. If retirement is viewed as infinitely distant, permitting one to neglect e^{-m}, the following expression for the logarithmic wage equation is obtained:

$$\ln w = \ln rV(s,z) + rs, \tag{4}$$

Interpersonal differences in s shift the wealth intercept and slope of the wage with respect to the discount rate, while differences in z affect the intercept. Thus, observations on ln w and s do not generally identify the wage function (1) or the optimal schooling attendance rule, $s = D(r,z)$. Observations on ability, z, and the financial constraint, r, may permit one to describe empirically the wage and schooling functions. If capital markets are perfect, and r is the same for everyone, differences in z may allow one to estimate r from a regression of the logarithm of the wage on years of schooling. This estimate does not describe how schooling affects the earnings of any particular person, because z may still influence how much schooling is optimal for each individual.

This interpretation of the wage equation (1) is called a reduced-form hedonic wage equation. It embodies both a school attendance equation conditional on r and z, and a wage function conditional on s and z (Rosen 1974 and 1977). This hedonic wage function does not presume to identify how individuals vary their school enrollment in response to human capital returns or how the derived demand for labor depends on the educational attainment of the worker. This hedonic interpretation of the wage function, however, admits more readily to the existence of market imperfections and unanticipated developments contributing to substantial disequilibrium rents in the implicit valuation of different types of inelastically supplied skills (Tinbergen 1956; Rosen 1977; Lucas 1977; Heckman and Sedlachek 1985).

The more common interpretation of the wage function is that developed by Mincer (1974) in which everyone is equally well off from a lifetime perspective; long-run equilibrium, achieved through compensating differences in costs and gains, leaves individuals indifferent among alternative levels of investment in schooling. In this case, ln rV(s,z) is

identical for everyone, or at least it is unrelated to schooling. Regressions of ln w on s provide estimates of r that can be interpreted as the average private internal rate of return on the opportunity costs of schooling for a representative individual.

To accommodate a monotonically declining rate of on-the-job human capital investment by workers after finishing school, Mincer (1962 and 1974) illustrates how a quadratic in post-schooling labor market experience, x, could describe proportionate changes in wages, net of on-the-job training costs:

$$\ln w_i = \ln w_o + rs_i\ a_1x_i + a_2x_i^2 + e_i, \tag{5}$$

where i now refers to the variables that are observed to differ across individuals, and e_i is the residual error that is assumed to be uncorrelated with all right-hand-side variables. When x is unobserved, Mincer (1974) approximated it by age minus age of entry into the school system, minus years of schooling completed. In other words, he assumed for males at least that they are attached full-time to the market labor force after completing their schooling. Hanushek and Quigley (1985) incorporate information on actual employment experience for males, assuming that on-the-job training is curtailed during spells of unemployment. For women, the above empirical approximation that all post-schooling experience is equally relevant to market earnings may seem particularly misleading. Mincer and Polachek (1974) demonstrate the differential effects of spells of market and non-market work experience on women's market earnings in the United States.

The post-schooling experience variable originally proposed by Mincer has the attraction of not being subject to the control of the individual, once schooling has been determined. Therefore, it is not a choice variable or one that is likely to be systematically correlated with unobserved market-oriented abilities or preferences; that is, it is not simultaneously determined. Women's actual entry into and exit from the labor force and even unemployment are endogenous choice variables, however, and must be jointly modeled with training investment, if the effect of labor market experience of women is

clearly an endogenous variable and cannot be included in a reduced-form wage equation.

This human capital approach poses four broad overlapping problems. First, the omission of variables that may determine wages, such as ability, from the above simplified specification of the earnings function may lead to biased estimates of the partial association between schooling and wages that is the basis for benefit-cost calculations or internal rate of return estimation.

Second, the profile of post-schooling, on-the-job training investment cannot generally be observed, although alternative proxies for Mincer's post-schooling investment profile have been proposed.

Third is the absence of suitable comparison groups. Observation of what particular persons would have earned if they had obtained more or less schooling than they actually did is not possible.

Fourth is a discontinuity between the conceptual framework and observations. Theory pertains to individuals investing in their productive capacity over a life cycle, but most data relate to different individuals of different ages, which are then combined to describe a "synthetic" life-cycle profile of earnings by age.

All of these problems in the human capital interpretation of the relationship between schooling and earnings could be viewed as "revisionist" in spirit. This is because they attempt to revise and reformulate the human capital concept, to modify its empirical specification, to use better estimating techniques for the wage equation, and to collect more appropriate data to bring the evidence closer to the core of the theory. Other critiques of the human capital interpretation of the education-wage regularity seek a fundamentally different way to explain how education influences labor market outcomes.

The primary alternative hypothesis is that of signaling or screening (Spence 1973; Arrow 1973). According to this view, education does not act to train or to socialize a worker to perform more productive tasks individually or in a team. Rather, education filters or screens the native ability or productivity of the worker, without enhancing it. Information on ability is signaled to the employer by the worker's investment of time and resources in the acquisition of schooling. A private rate of return from schooling may still be inferred from the schooling-wage relationship, but the social return to schooling becomes a more complex issue if the screening hypothesis is accepted in its entirety. The production of information needed to assign more able workers to jobs in which these abilities are more productive yields a social product. What is not clear is whether education is an efficient mechanism for matching workers and jobs. To many observers, education would seem to be a time-consuming and costly way to screen for the ability of workers, if schools do not also augment their skills. If an alternative screen worked as well as education but had lower social costs, then the alternative scheme would be socially preferable to education.

The simple fact that no society, capitalist or socialist, has pursued an alternative scheme to education to produce the information needed to match workers to jobs casts doubts on the validity of this extreme form of the signaling hypothesis. A more moderate interpretation would hypothesize that school credentials provide an important source of information in the labor market on worker productivity, one that employers can readily access at low cost. Educational attainment is a means of discriminating statistically among workers in hiring; it is also a means that is accepted by some as "fair" (Blaug 1985); many other individual characteristics such as race, sex, age, marital status, and ethnic group, which might be used to discriminate statistically are increasingly challenged by some as socially unfair.

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